Thermos + Kettle = Thettle

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Introduction

Drinking hot beverages is commonplace within the diet of most Americans. In a survey conducted at the University of Michigan, we found that nearly half (49.2%) of students are having at least one hot beverage a day. The challenge that these students have is acquiring these beverages. There are 3 general ways to get a hot drink; make at home with a kettle or traditional coffee machine, make at home using a Keurig, or buying them at coffee shops. Most Americans are perfectly fine with filling their thermos with tea in the morning or buying a latte at Starbucks. However, 21.4% of students are drinking more than 1 hot drink a day. How do these people get their second drink? They must either go home to their kettle, which is inconvenient, or buy another one which is expensive. Our product allows users to get that second drink in a convenient and affordable fashion.

Our product is the Thettle. It is a vacuum insulated mug that can be plugged into all standard electric outlets to create boiling water within minutes. Nothing about the technology or engineering is revolutionary. What we are doing is combining existing technology into a new product, which will then serve a specific market niche.

Our primary target market is Asian immigrants. In our survey of Michigan students, we found that students who were Asian or Pacific Islander were far more likely to have multiple hot beverages a day than their peers. In countries such as China, hot water and kettles are as common as drinking fountains are in America. In Chinese culture, hot water is perceived as healthy and helps keep your body in harmony. Since they are so accustomed to this convenient hot water, our product will fulfill their unmet need while in America.

Existing thermos kettle hybrids either do not use enough power to actually boil water, or are very expensive and marketed more towards campers. Other competition includes these thermoses, normal kettles, single serving coffee machines, and coffee shops. Our product combines the convenience of the coffee shop with the cost price of a kettle which will attract busy and cost constrained Americans.

The Thettle project has been in the works for 2 years. The purpose of this report is to serve as a full overview of the project, history, engineering, and business proposition behind Thettle.

History

The idea for Thettle was created by Sarah Wang for the University of Michigan class “Entrepreneurial Creativity”. This product would allow consumers to make hot beverages “on the go” so they could have a fresh cup of tea or coffee whenever they want. All that is needed is access to hot water and a standard electrical outlet.

The first prototype Thettle was built at the University of Michigan Makeathon in 2017. It came in 1st place in the open design portion of the competition and won the National Instruments award for accelerating innovation along with an award for social engaged design. The second prototype Thettle was made that summer which improved on the heating time of the product. The third

prototype was finished in 2019 and made for the purpose of completing an engineering honors capstone.

The team also competed in entrepreneurship pitch competitions. Thettle competed in the 2017 Accelerate Michigan Competition and placed in the top 6 teams of the 30 which made it to the semi-finals. Thettle also pitched at the Michigan Business Challenge in 2017 where we made it to the first round. The goal of competing in these competitions was to raise funds to build a sophisticated prototype and eventually create a Kickstarter to fund full production. Despite previous successes, there are currently no plans to bring Thettle to the mass market.

Prototypes

Thettle followed the "build early and build often" philosophy. All the money Thettle won was put towards making prototypes that would help us design the technology behind the product and garner consumer feedback. A total of three prototype Thettles were created.

Iteration 1

The first prototype Thettle was created at the University of Michigan Makeathon in 2017. This prototype was based off a Zojirushi thermos and used a circular ceramic heating element. Power came from an 18V DC laptop charger and an Arduino microcontroller with analog temperature sensor and mechanical relay was used to control it. It would heat up to the desired temperature and the relay with temperature sensor would ensure it maintained the constant temperature. This Thettle would take around 2 hours to bring water to a boil. This prototype can be seen in Figure 1 below.

Figure 1) 1st prototype Thettle created at the University of Michigan Makeathon. The electronic components were placed outside of the 3D printed housing below the thermos.

This Thettle competed in the open design portion of the competition where it placed 1st, winning $500. We also won the National Instruments award for accelerating innovation winning $250 and a social engaged design award winning us $50. This money was put towards building the second prototype.

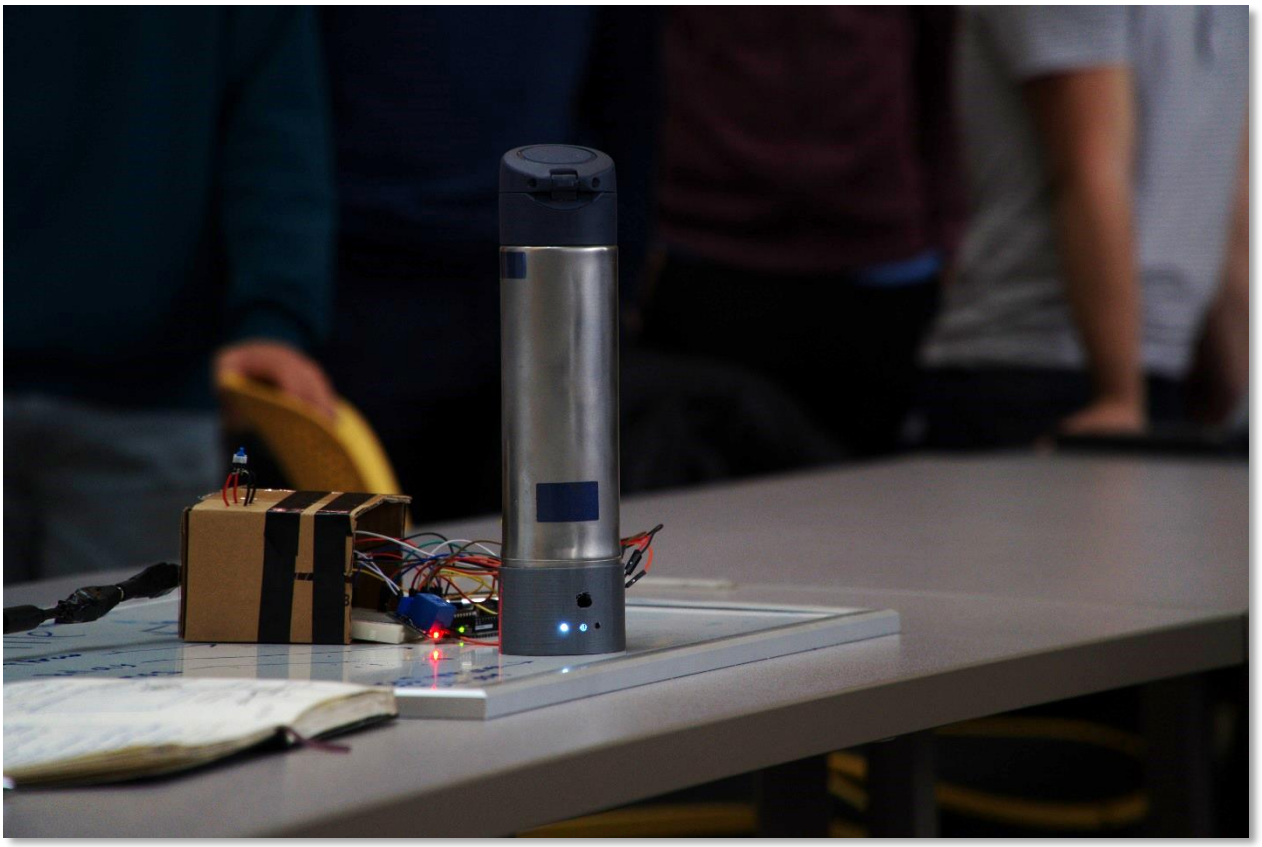

Figure 2) The 1st Thettle prototype being presented at the Makeathon

Iteration 2

The second prototype Thettle was made during summer 2017 using the funds won at the Makeathon. The base of the prototype is the same Zojirushi thermos and uses a flat ceramic heating element to heat it. Power comes from a 120 VAC power source and a manual switch turns the product on/off. The power cord is glued into the base and can wrap around the thermos for convenient storage. This Thettle could bring water to boil in 30 minutes. This prototype can be seen in Figure 3.

Figure 3) 2nd prototype Thettle created during the summer 2017. All the electrical components were placed inside the base and a basic power switch controls current across the hearing element.

Iteration 3

The third prototype Thettle, see Figure 4, has a massively improved heating time. It can heat water from room temperature to boiling in 3 minutes. The cord is detachable from the base using a standard NEMA 15 plug. Additionally, it includes a french press attachment in the lid which allows you to push coffee beans or tea leaves to the bottom of the thermos after steeping. The thermos has two welded stainless-steel walls so the outside is still safe to hold while the contents are boiling. A flexible heating sheet wraps around the inside wall to heat it. The lid and base are 3D printed using ABS plastic which has a glass transition temperature above 100 °C. the maximum expected temperature of the thermos.

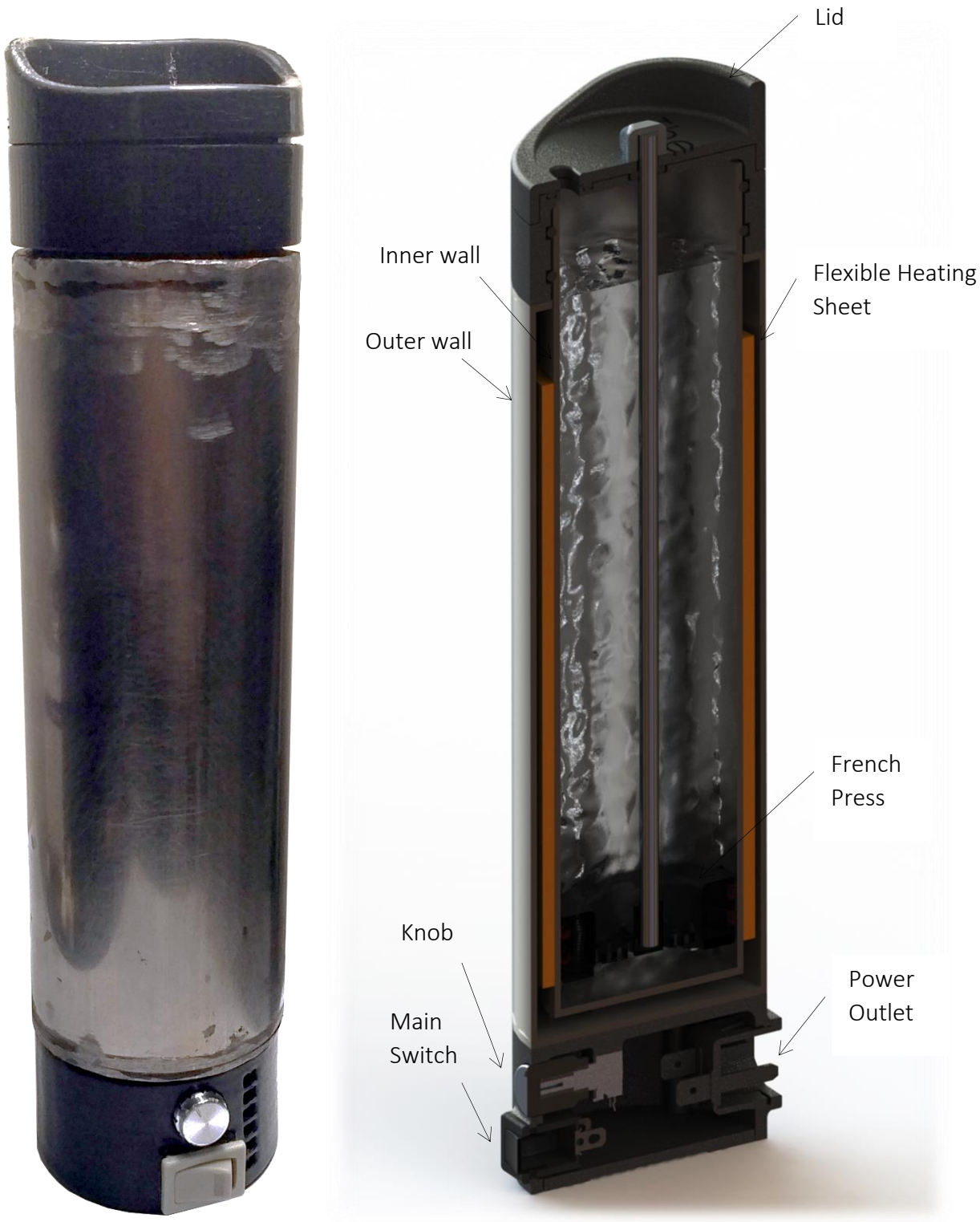

Figure 4) 3rd prototype Thettle which can boil water in 3 minutes and has a detachable power cord

Figure 5) Lower housing of the thermos where the power cord plugs into. The main switch controls power to the system while the knob adjusts the target temperature of the thermos. The six LED indicators display the actual temperature of the thermos.

This thermos also includes a french press attachment in the lid (see Figure 6). This is a plunger that travels the interior chamber of the thermos with a steel mesh with 0.003” openings on the bottom. With this, users can put coffee grounds or tea leaves in the thermos and then, once the beverage is steeped, they push the french press down to remove the grinds from the drink.

Figure 6) French press plunger which utilizes a steel mesh with 0.003” openings to filter out coffee grounds or tea leaves from the beverage. A double O-ring seal prevents leaks around the edges of the plunger.

Figure 7) Lid of the thermos. It has a hole for the french press and an opening to drink out of. The lid rotates to close and uses O-rings to seal it.

This thermos was designed such that a low voltage controls system would be implemented into the base. A 120VAC -> 5VDC converter would power an ATTiny 44 which would control the heating element with a mechanical relay. The controller would read the temperature of the thermos using an analog temperature sensor glued to the inside wall of the thermos. The user interacts with the controller using the knob connected to a potentiometer and this tells the controller how hot the user wants the beverage to be. The controller than uses the mechanical relay to maintain this temperature. It also controls six LED indicators that tell the user how hot the beverage currently is. The wiring diagram for this system can be seen in Figure 8. While this system was designed for the thermos, it was not implemented. The purchased DC converter was unable to provide a constant 5V signal during testing and the temperature sensor was shorted during manufacturing. Due to these problems, the electrical system was simplified to only include a main power switch to turn the heating on and off.

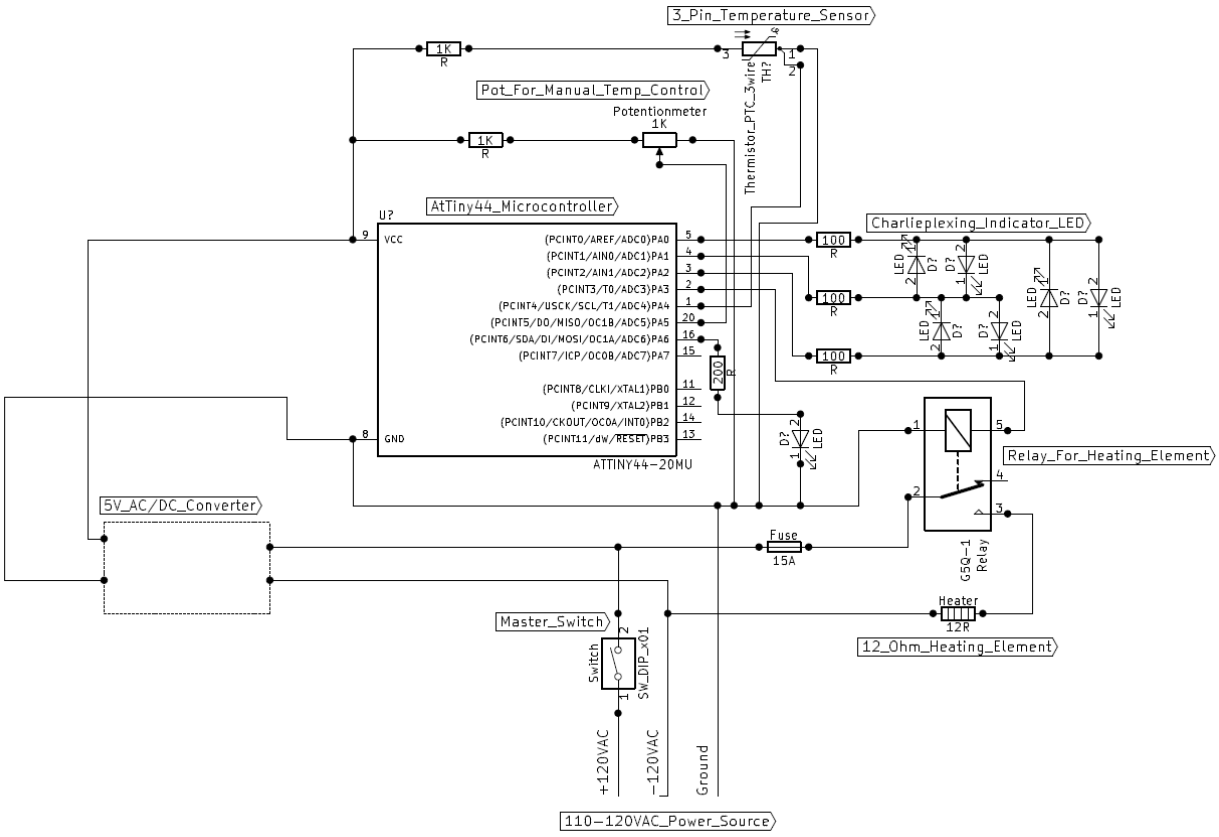

Figure 8) Wiring diagram of the Thettle. Most of these systems were not implemented due to failure of the 5VDC converter and analog temperature sensor.

Iteration 4

A 4th prototype Thettle was designed, but not constructed (see Figure 9). This Thettle was not designed for prototyping, but for mass manufacturing. Rather than using steel tubing as in iteration 3, this Thettle uses very thin steel sheets formed to size while still maintaining a reasonable safety factor. The lightened walls greatly reduce the weight of the thermos and the thermos can hold much more fluid while maintaining the same outside diameter. It also uses a custom tubular heating element which is much cheaper than flexible heating sheets.

Figure 9) Computer rendering of the 4th Thettle iteration. It uses a tubular heating element to reduce manufacturing costs and has much thinner steel walls to reduce weight and footprint of the thermos.

Business Plan

We investigated Thettle not just from an engineering perspective, but also analyzed the business behind Thettle to see if it could be a viable product. When examining a business idea, the most important things to consider are the problem (or opportunity), solution to the problem, competition and competitive advantage, and target market.

Problem/Opportunity

Every morning, I look forward to the whistling of my kettle and the smell of a fresh, hot cup of coffee brewing in my french press. I take out my trusty red Contigo thermos that follows me everywhere, fill up a single serving of hot coffee or tea, and head out the door to class. I am ready to enjoy lecture while cozying up to my fresh, hot beverage. However, much like how we all finish the popcorn before the movie starts, I finish my hot beverage on my walk before I even get to class. When I arrive at class, I don't have my kettle to make myself a second beverage to enjoy in class as I had desired. Now, my only option is the University's overpriced coffee shops

that are cleverly placed near every popular classroom building as if the University knows my weakness.

Looking around the rest of the day, I noticed a majority of people around me also carrying around a trusty thermos sidekick in their bags. Approaching these people with questions, I found that they too experienced the same problem where they would leave the house with a hot beverage in their thermos in the morning, finish the drink much too soon, and have to carry around a useless empty thermos for the rest of the day. This population of people that enjoy hot beverages and are on the go daily experience the problem of either suffering from a lack of convenient access to hot beverages or overspending at nearby overpriced coffee shops. As coffee consumption grows and continuously ingrains itself as an American lifestyle, coffee is becoming the average busy American's new best friend.

In addition to Americans' need for access to hot beverages conveniently and affordably on the go, the over 2.3 million Chinese-born immigrants in the United States are suffering from a lack of access to hot water. Where there are cold water fountains around every corner in the United States, there are usually carts holding a kettle full of hot water in China. The Chinese culture only consumes hot water. For the over 70% of the 2.3 million Chinese-born immigrant population that are over the age of the 30, the lack of convenient and accessible hot water in the United States is a startling culture shock. The cold water the Chinese-born immigrants have to drink as an alternative feels sharp and causes them health concerns. As the child of Chinese-born immigrant parents, I see this suffering first hand when my parents complain about cold water fountains or when friends and relatives visit and cringe their nose in pain at the glass of cold water served at every restaurant in the U.S. After further research, I have also found that there are other cultures that are accustomed to drinking hot water, such as India and share this suffering as foreign immigrants. The United States, as the melting pot of all cultures and backgrounds, has a responsibility to cater to all its people's diverse needs to offer everybody a quality of life to enjoy.

Solution

Our product will solve these problems. We have created a consumer device that combines an electric kettle with a portable thermos which will allow consumers to make hot water wherever they go. It looks just like and has a similar size to a standard thermos. The consumer can fill it up at any ordinary water fountain and then plug the thermos into a standard wall outlet using a detachable cord. After 3 minutes, the water will boil. The consumer can then enjoy the hot water, or they can make tea using a tea steeping attachment which we will also sell, make fresh coffee using our french press lid attachment, or hot chocolate with hot chocolate powder. This device, dubbed the Thettle, will allow consumers to have easy access to hot beverages and allow them to make a hot drink wherever they are.

In addition to added convenience, the Thettle serves as an affordable alternative to existing methods of acquiring hot beverages. By making the drinks yourself, the consumer can avoid the upcharge placed by coffee shops. We have found that some coffee shops have even started charging for plain hot water so the Thettle will allow consumers to have free hot water at their reach. Using initial analysis of manufacturing costs and customer demand, the Thettle will be

priced at $39.99. This is how much most consumers pay for both their thermos and kettle and since the Thettle serves as a substitute for both of these products, it is set at a price they can pay. Additionally, if the Thettle saves you from purchasing a $3.25 drink from your local coffee shop every day, it will pay for itself in under 2 weeks.

Competition

The most similar product to the Thettle is the Cauldryn Coffee Travel mug. It does exactly what Thettle does, bring water to a boil, and is powered either by battery or 120 VAC wall outlet. There are two versions of the Cauldryn. There is an expensive $130 version which has an LCD display for precise temperature monitoring, boils water, and even has a blender. There is also a cheaper $70 version which can heat water to several settings, including boiling, when plugged into an attached stand. While the Cauldryn does have the same features of the Thettle, the additional features are unnecessary and the Cauldryn is marketed towards campers rather than our target market. A blender is unnecessary since the goal is to just make hot drinks. The battery, is also not needed since our users will almost always be close to an electrical outlet. Appearance wise, the Cauldryn, does not look like a normal thermos and looks more like a water bottle. The Thettle does not have the extensive features of the high end Cauldryn but is much cheaper than even the lower end Cauldryn and has a sleek design, more appealing to our target market.

Other similar products on the market include heated travel mugs, kettles, and single serving hot beverage appliances such as Keurigs. Heated travel mugs maintain one's drink temperature and are powered by a car cigarette lighter receptacle or USB cable. However, a cigarette lighter receptacle can only provide 12VDC whereas our product uses a 120VAC heating source. These heated travel mugs differ from our product in that they only warm or maintain the heat from the contents of the mug and cannot bring room temperature water to a boil since they operate on low power. In essence, heated travel mugs act as only a thermos, maintaining the temperature of a beverage. The same applies to the Ember temperature control travel mug. While appearing similar to the Thettle, it is in actuality very different since the Ember cannot boil water; it only keeps beverages warm. Thettle combines the function of a kettle and a thermos together providing hot, clean water to consumers. This caters to the consumers' needs to make tea, coffee, or simply hot purified water on-the-go.

Our current competition is companies that sell hot beverages or make appliances that provide such hot beverages to customers, such as a coffee shop, and tools that allow customers to easily create their own hot beverages

Table 1. Market competitors and how the Thettle compares

Hot beverage source	Convenience	Cost	Taste	Speed	Refillability
Coffee Shop	Best	Poor	Best	Good	Poor
Single Serving machine	Good	Decent	Good	Best	Good
Electric Kettle or coffee maker	Poor	Best	Good	Decent	Best
Our Product	Best	Best	Good	Good	Best

Coffee shops are very convenient since you can typically find one on any corner and will give you a delicious drink in under five minutes. However, you only get one drink and the beverages are very expensive. Single serving machines like a Keurig are fairly convenient since they are found in many offices and are easy to use. They give you a decent tasting drink quickly and for a low price. Since the price is low, it is easy to get another drink. Electric kettles and coffee makers are more high maintenance as it takes longer to make your drink and they require more cleaning. Despite this, these sources are very cheap, taste good, and give you many drinks with one brew. Our product provides hot beverages to the customer at the speed and convenience of a shop, but with a much-reduced price tag. The customer may be slightly more limited in selection and complexity of beverages relative to a major coffee shop such as Starbucks, but the reduced cost and ease of accessibility to multiple drinks is what gives our product the competitive edge over such vendors.

Through a review of patents, we have also found that Thettle is a novel invention and does not infringe on existing intellectual property. However, it is not non-obvious since Thettle is combining two similar products so patenting Thettle would be difficult and expensive.

Target Market

Our primary customer segment is Chinese immigrants in America. In China, drinking hot water is the norm. Every building has an electric kettle and the idea of drinking straight cold water is foreign to people in china. When these Chinese immigrants come to America, there is a huge culture shock. Hot water is much harder to find in America. Instead, there are cold water fountains on every corner. Chinese immigrants must make hot water at home with their electric kettle and carry it around in their thermos all day. This is a group of people who are already accustomed to carrying around a thermos and put great value on having hot water wherever they go. With over 2.3 million Chinese immigrants in the U.S. in 2016 and only increasing in the past 30 years from 384,000, there is a large population that would benefit from a product like Thettle that eases the culture shock of arriving a new country.

Our secondary customer segment is the rest of the U.S. population that enjoys hot beverages on the go. The current method of obtaining hot beverages for this population is by making one with a kettle or thermos at home or purchasing one at a coffee shop. However, after making a hot beverage at home and pouring it into a thermos to take to go, one will finish his or her drink and be unable to make a second hot beverage. The second method of purchasing hot beverages at a coffee shop is expensive with a cup of coffee ranging from $2-$5 spent each day amounts to $60-$150 in a month if one beverage is purchased each day. Thus, at an estimated unit price of $39.99 per Thettle, our product would save the user money in the long run.

Regarding our product's market, there is a steady growth in revenue hot drinks sold in stores, on-trade sales of 4% per year, and a revenue of $17.52 billion in 2017. Electric kettle sales are also large with 3.3 million units sold in 2016. Our product will enter in both of these markets as a hybrid of the two. Both of these markets are very large and segmented; there are many physical stores that sell hot drinks and dozens of different brands of electric kettles and single serving machines. A large segmented market is much easier to enter than a smaller more centralized one since there is more room for competition and new competitors to enter.

Discussion

This project has yielded a working prototype that is capable of boiling water in 3 minutes along with an examination of Thettle's protentional role in the hot beverage market. While we do not currently plan on bringing this project any further, I still believe that it has potential. Thettle provides convenient access of hot beverages which is highly valued by a large segment of Americans. We have proven that the technology works and can be implemented in a small form factor. Similar thermos products currently on the market serve similar consumer needs but include far more features than necessary. They seek to be an all-encompassing product and cost an exorbitant amount of compensate for all these features. I believe that what the market needs is a simple product like Thettle that may only heat water, but it does that one function very well for an affordable price.

For more information about Thettle or business inquiries, please contact dhvd@umich.edu