Project Nepton

R. Chen, H. Ferrabolli, J. Wong, J. Wong

***Abstract*—The Nepton is a hot beverage container designed with its user in mind. It has two primary functions: alerting the user when his or her hot beverage is at a safe and satisfactory temperature to consume, and reheating the beverage should the temperature fall below desired levels.**

I. Introduction

In a society surrounded by hot beverages, we have all, to our dismay, experienced the Goldilocks principle. We have all had a similar experience: drink an overly hot beverage, realize that it is too hot, place it down to cool, and come back later only to learn that it is now too cold. It is difficult to know when the drink is just right. Moreover, when sipping the hot beverage over a lengthy period of time, it tends to cool down faster than we would like. Enter the Nepton. Our product would address both these issues by providing an E-ink notification system for drink temperature and a proprietary reheating system. It would additionally integrate seamlessly into the digitally connected, smartphone wielding consumer's lifestyle via a convenient app. The app would minimize the need of physical buttons on the Nepton, lending to the minimalistic design, while also allowing easy setup and providing powerful functionality on one's phone and leveraging notifications to compliment the physical indications on the Nepton.

As referenced in our Appendix, a market survey was also disseminated to evaluate the market need for the Nepton. After examining over 100 replies, we have identified two potential markets, one that believes their hot beverage drinking experience could be improved and one that does not own or use a thermos. In the former, it was identified that they regularly used thermoses but couldn't accurately determine the temperature of the liquid inside and whether it is safe to drink. In the latter, it was identified that that those who do not use thermoses choose not to due to their inconvenience. The Nepton addresses both those markets through it's heat sensing capabilities and convenient design choices (fits in most cup holders, easy to clean, lightweight). In our research into the hot beverage market, we also discovered the shocking revelation that consuming overly hot tea, one of the most popular hot beverages in the world, was linked to esophageal squamous cell carcinoma, a form of esophageal cancer. The Nepton would attempt to mitigate this risk by warning users when the drink is past the safe drinking temperature of 137 F. In terms of existing products, there have been smart thermoses created, such as the SmartGear Thermos (See Appendix), but the Nepton is the first that is autonomous from any cable, is calibrated to the user's temperature preference, and alerts the user in a pleasing, simplistic way.

Our group's methodology in approaching this project was to brainstorm difficult or unpleasing situations we encounter daily and then formulate an invention to address it. After the Nepton was conceptualized, the next step was to determine if a market need was present. Surveys were disseminated at this point and a market was evaluated. The following step involved researching feasibility (Proof of concepts can be seen in the Appendix) and designing the product. After the design is complete the prototyping stage begins. The group will perform iterative development, starting with the physical components to facilitate testing. We will develop individual portions of the Nepton and then proceed to integrate and test. The app will be developed in parallel and will be integrated after the hardware has been integrated. We plan to utilize for funds what SASE has provided as well as out-of-pocket funding if necessary.

II. Product Concept

From the user needs gathered and interpreted in the survey, the group then converted those consumer needs into system needs. These system needs are more quantifiable so the group can measure exactly how well the consumer needs are satisfied. Please refer to the appendix for more details.

The Nepton is a ground-breaking hot beverage container that is personally tailored to the modern, digitally-connected consumer. The Nepton's main features are its reheating ability, that can also be used to maintain a specific temperature if so desired, and its revolutionary e-ink outershell. The device has the ability to reheat liquids from 25 C (room temperature) to 54.4 C (optimal hot beverage temperature) in less than an hour. The Nepton can also maintain a specific temperature for at least 2 hours. Furthermore, the temperature sensitive e-ink shell acts as a visual indicator to provide alerts and to let the user know the temperature of the beverage at all times by altering the intensity of the e-ink color/pattern, without the user having to

This work was created for the Innoservice competition for the Society of Asian Scientists and Engineers (SASE), sponsored by Proctor & Gamble. InnoService is a design competition developed by SASE, a national organization dedicated to the advancement of Asian heritage scientists and engineers in education and employment so that they can achieve their full career potential. The project was founded for collegiate chapters to not only develop new technologies using their scientific and engineering backgrounds, but also demonstrate their ability to sell their ideas.

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physically pick up the drink and take a sip. This is all tied together by our state-of-the-art app that allows the user to have complete control over their Nepton, where they can input their preferred beverage temperatures and customize other parts of the Nepton such as the changing pattern of the e-ink.

Every successful project involves the delivering of results that add value. While the Nepton is a product that our team believes has a definitive market need, it is also something capable of being modeled, constructed, and delivered. The Nepton utilizes existing technologies to achieve its two primary functions: detecting/displaying temperature and heating container contents. Detecting liquid temperature is done by utilizing a thermocouple that contacts the liquid. The thermocouple connects to a small microprocessor which analyzes and transmits the data to a Bluetooth transmitter that connects to the companion app. A functional companion app UI can be seen in the Appendix.

The main calculations needed was how much energy the heating element would require, and how long the heat transfer from the heating element to the liquid would take. For the sake of calculation, the group calculated the energy required to raise the temperature of water from 25 C to 54.4 C, and then calculated the energy that the group's battery could deliver. The group found that the Nepton battery could successfully heat the 16 oz. from room temperature to optimal temperature twice before needing to be recharged. The group also used electrical engineering principles to calculate the time this process would take, which come to around 50 minutes.

Fulfilling the consumer requirements are linked very deeply to every major subsection of the Nepton. The technology utilized in the Nepton includes the heating coil, the e-ink notifier, the thermocouple, the body and the application, and they fulfill the consumer needs and system acceptance criteria. These technologic components and their specific respective links to consumer requirements are shown in more detail in the supporting documentation.

III. Resources and Timeline

The approximated cost of Nepton's raw components is ~$40. The expected costs of custom machining for the body and heat sink, the team anticipates the prototyping cost of the Nepton to significantly increase this cost. Multiple prototype iterations would be required to arrive at an alpha-stage prototype and realistically, the team anticipates the overall cost to be in excess of $1,000. A final prototype would be reasonably expected to be well in excess of $5,000.

The team's project schedule for the planning process and prototyping process can be seen in the Gantt chart within the appendix.

Innoservice Final Report
Team Nepton

R. Chen, H. Ferrabolli, J. Wong, J. Wong

Contents

INNOSERVICE FINAL REPORT - TEAM NEPTON

Team Members and Roles:

Hyun June Ferrabolli - *Team Leader*

Jonathan Wong - *Programmer/Electricals*

Jason Wong - *Product Engineering*

Ryan Chen - *Product Design*

Executive Summary

The Nepton is a hot beverage container designed with its user in mind. It has two primary functions: alerting the user when his or her hot beverage is at a safe and satisfactory temperature to consume, and reheating the beverage should the temperature fall below desired levels.

I. Project Background

In a society surrounded by hot beverages, we have all, to our dismay, experienced the Goldilocks principle. We have all had a similar experience: drink an overly hot beverage, realize that it is too hot, place it down to cool, and come back later only to learn that it is now too cold. It is difficult to know when the drink is just right. Moreover, when sipping the hot beverage over a lengthy period of time, it tends to cool down faster than we would like. Enter the Nepton. Our product would address both these issues by providing an E-ink notification system for drink temperature and a proprietary reheating system. It would additionally integrate seamlessly into the digitally connected, smartphone-wielding consumers lifestyle via a convenient app. The app would minimize the need of physical buttons on the Nepton, lending to the minimalistic design, while also allowing easy setup and providing powerful functionality on one's phone and leveraging notifications to compliment the physical indications on the Nepton.

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II. PROTOTYPE

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Every successful project involves the delivering of results that add value. While the Nepton is a product that our team believes has a definitive market need, it is also something capable of being modeled, constructed, and delivered. The Nepton utilizes existing technologies to achieve its two primary functions: detecting/displaying temperature and heating container contents. Detecting liquid temperature is done by utilizing a thermocouple that contacts the liquid. The thermocouple connects to a small microprocessor which analyzes and transmits the data to a Bluetooth transmitter that connects to the companion app. A functional companion app UI can be seen in the Appendix.

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components and their specific respective links to consumer requirements are shown in more detail in the supporting documentation.

Given the time and funding provided by SASE, the group was able to create a completely functioning prototype of the Nepton. All components present in a functioning finished product are present in the current prototype, the difference being the implementation. With the limited funding, many certain components that would need to be custom-made had to be bought commercial off-the-shelf. These components were then modified as far as possible given the limited tooling and manufacturing capabilities. The raspberry pi is much larger than the intended final board. The e-ink notifier, which would normally encompass the full outer shell of the Nepton, is represented by a 3 by 2 inch notifier. Certain unruly wiring through the cap would not exist in the final product. An extension was made for the bottom of the case to represent the full depth of the enclosure that would house all the internal components. We had to make these modifications for the current alpha prototype, and we have solutions for each of them given more funding and time.

III. RESOURCES AND TIMELINE

The approximated cost of Nepton's raw components is ~$40. The expected costs of custom machining for the body and heat sink, the team anticipates the prototyping cost of the Nepton to significantly increase this cost. Multiple prototype iterations would be required to arrive at an alpha-stage prototype and realistically, the team anticipates the overall cost to be in excess of $1,000. A final prototype would be reasonably expected to be well in excess of $3,000.

The team's project schedule for the planning process and prototyping process can be seen in the Gantt chart within the appendix.

IV. BUSINESS STRATEGY

One of the most important aspects of team Nepton’s business strategy is the manufacturing and supply chain. Based off our financial analysis, the team has determined that the Nepton will cost approximately $60 for raw materials and manufacturing. Given this information, the team decided price the Nepton at $100 as it is a premium product. With this pricing model, we are projected to have 40% profit per unit sale. To reduce manufacturing costs,we plan to outsource our manufacturing as well.

Distribution will occur through both online retailers such as Amazon as well as brick and mortar consignment channels. The former allows a large amount of

users while the latter will facilitate customers physical interaction with the product to inspect and demo. Beginning with consignment stores is to offset the fact that we are a startup. It is a mutual relationship that allows us to place our product into a physical store while also allowing the vendor to assume less risk as they do not have to pay for the product until it sells.

Project Background

A. Consumer Insight

Nepton's survey was presented to a sample of over 100 individuals under the general title of "Hot Beverage Product Survey." The purpose of this survey was to identify a market opportunity for Nepton. The survey asked participants approximately 10 questions pertaining to their experiences drinking hot beverages or with hot beverage containers. The following are examples of several questions that were asked in the survey:

a. *From where do you typically get your hot beverages?*
b. *Which of the following complaints, if any, apply to your experiences with hot beverages?*
c. *What are some reasons you do not use a thermos?*

Based from the results of the survey, the team has identified two potential markets for Nepton.

a. Individuals who own a thermos but feel that their hot beverage experience could be improved.
    i. 34 individuals responded that they regularly used thermoses or similar non-disposable heat retention containers
    ii. Of those 34, 16 responded that one complaint they had with their thermoses was that they were unable to tell when the beverage inside was at a satisfactory temperature for consumption.
b. Individuals who do not own or use a thermos.
    i. 66 individuals responded that they did not regularly use thermoses or similar non-disposable heat retention containers.

ii. Of those 66, 20 responded that thermoses were aesthetically unpleasing and 32 responded that they did not see a need for a thermos.

The team is targeting these two potential markets with an emphasis on features of Nepton that address the issues brought up by the surveyed. The inability to tell whether the beverage inside a thermos is at a satisfactory temperature for consumption Nepton's easily identifiable color-changing feature that alerts the user to the temperature stages of the beverage (Too hot, satisfactory, lukewarm). Inconvenience in using and/or carrying a thermos and inclusion of an adjustable carry-strap that allows Nepton to be carried alongside a bag or slung on the shoulder.

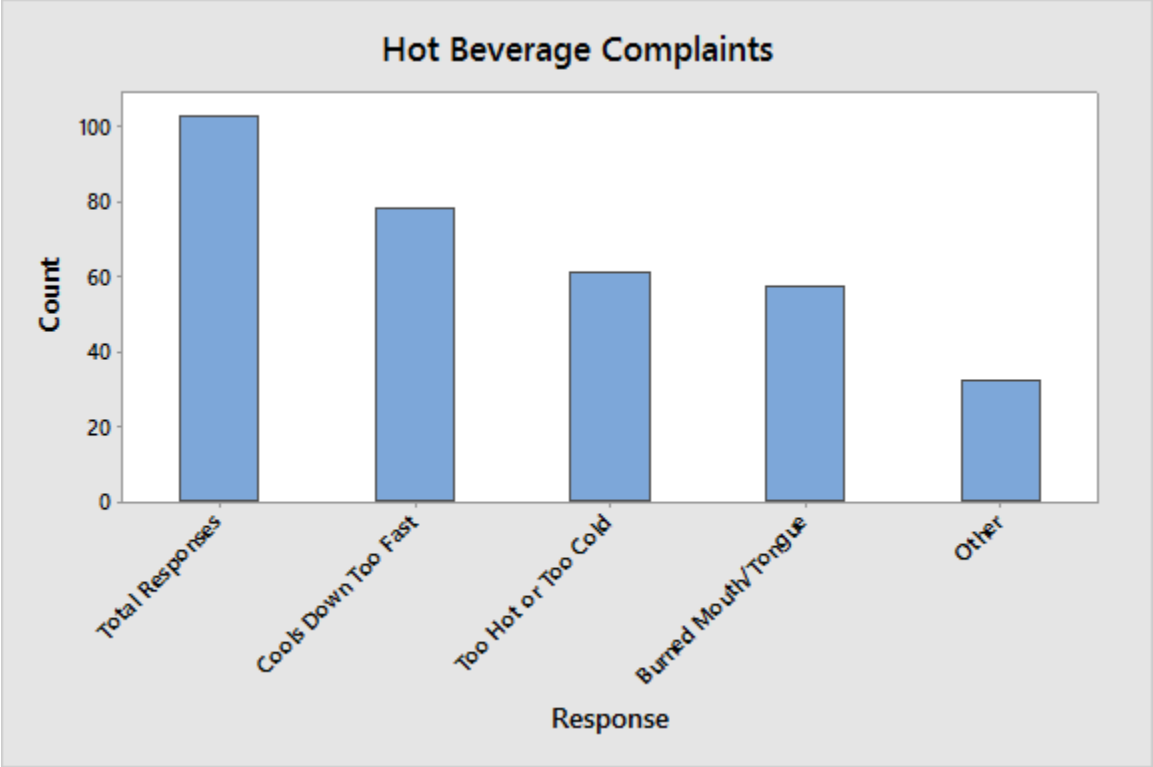


Figure 1: Survey Results – "What are complaints (if any) with your hot beverage experience?"

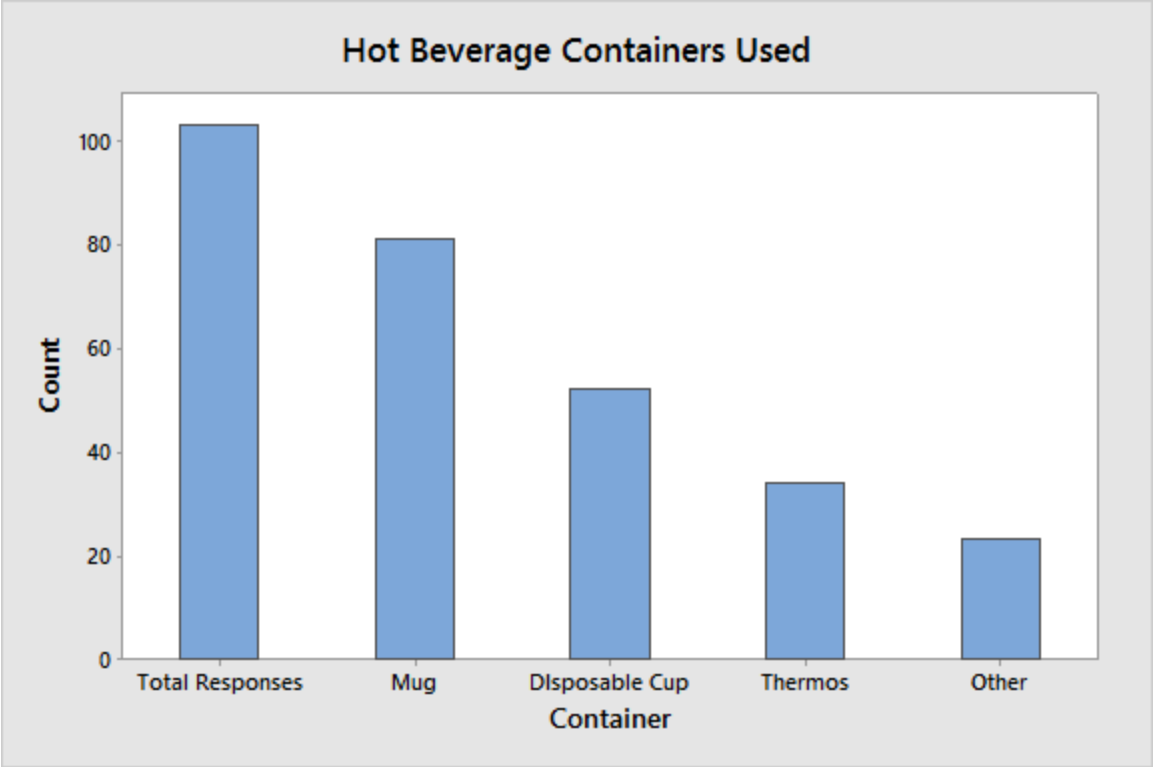


Figure 2: Survey Results – "What container(s) do you use to consume hot beverages?"

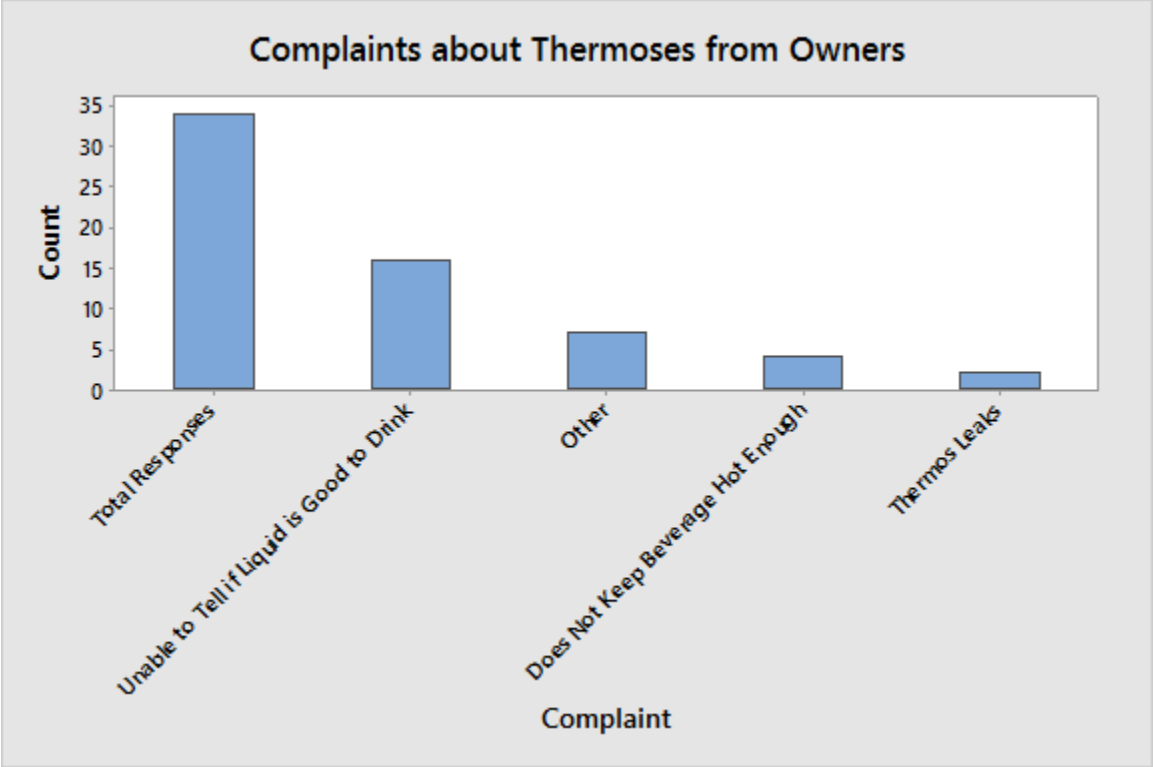


Figure 3: Survey Results – "What are complaints (if any) with your thermos?"

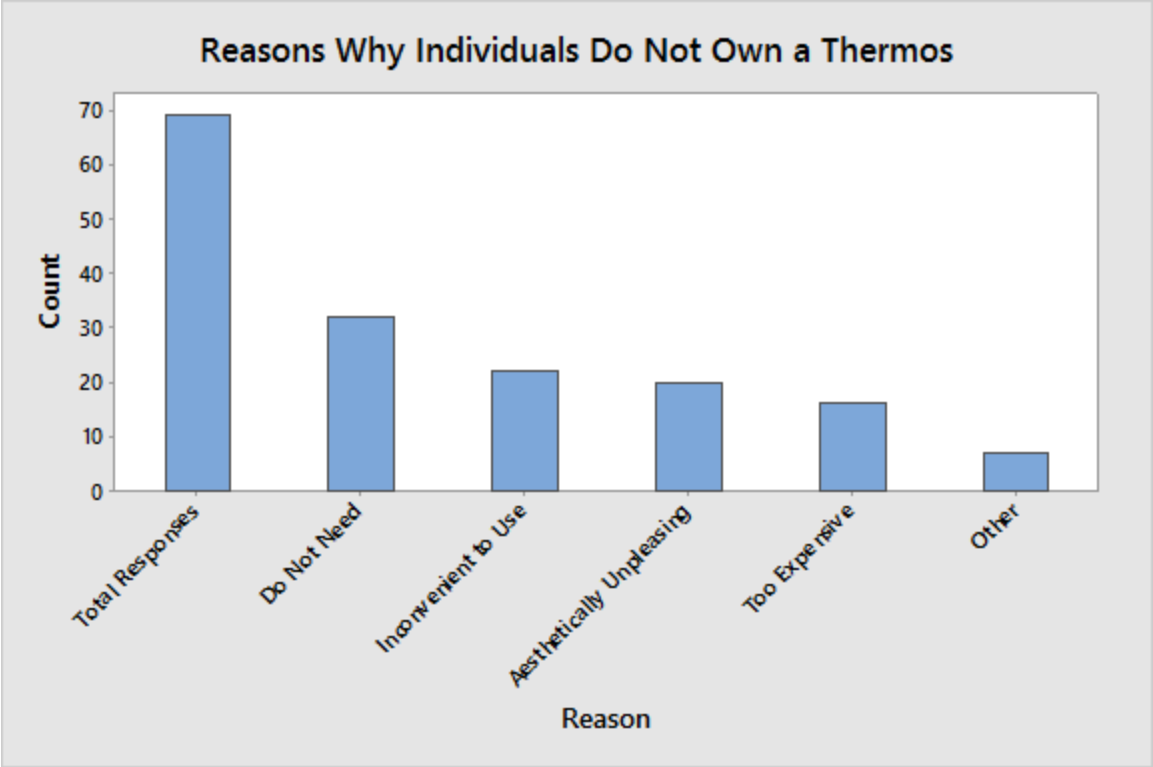


Figure 4: Survey Results – "What are reasons you do not own a thermos?"

B. Relevance to Digitally Connected Consumer through Customer Analysis

In 2014, 4.55 billion people owned a smartphone, and that number is only expected to rise. As smartphone and high speed internet technology become more and more affordable, the average consumer is quickly becoming a digitally connected consumer, whether they like it or not. Smartphones also offer a whole host of benefits to their users. The convenience of constant connectivity to the internet, communication options, applications and the all-in-one power of smartphones, explains why their usage has become so popular. Smartphones using consumers are a huge demographic, one that is continually growing today.

In order to take advantage of the inherent convenience and connectivity of this technology, the team sought to integrate the Nepton to the digitally connected consumer. Since the team aspired for the Nepton to fit seamlessly into the consumer's current lifestyle, we developed an application for iOS for all iPhones so that the consumer can control the Nepton features wirelessly. The application has

the advantage of bringing all the technical feature of the Nepton straight to the digitally connected consumers' fingertips. The Nepton allows the user to input different drinks, calibrate the temperature sensor to their personal optimal drinking temperature, reheat their beverages and more. The app also displays the battery charge of the Nepton, allows for different e-ink patterns, and displays a health warning when the drink is too hot.

C. Existing Technology

Our product is truly one of a kind. No other product has the same subtle color shifting abilities and convenient temperature controls as the Nepton, all neatly packaged into our precision cut stainless-steel unibody container. Other manufactures have tried creating generic novelty mugs that change between two static images when a hot liquid is poured into it. The Nepton utilizes electrophoretic ink to gracefully shift colors on a gradient that constantly reacts to the temperature of the liquid inside, thus always giving you visual feedback to the state of your drink.

Other self-heating containers rely on physical motion such as shaking the container to generate enough energy to heat up the liquid, which is both inconvenient and impractical, especially for hot drinks like coffee or tea. Other approaches, such as the single-serving self-heating can by Wolfgang Puck, is not reusable and relies on a dangerous chemical reaction that has reportedly led to cans exploding, overheating, and even melting. The Nepton uses an internal electric heating system that does not require any physical action from the user to power. The Nepton also runs on a smart alarm system that automatically turns the container off when it reaches its critical temperature, so you don't have to worry about it exploding.

D. Identify Unmet Market Need

As mentioned in Part A (Consumer Insight), a survey on users' beverage consumption habits and preferences were completed by over 100 individuals. From the survey results, the group identified clear market needs that were not being met by any current product on the market. Those needs were hot beverages were cooling down too quickly, beverages were either too hot or too cold, and an inability to tell if the beverage is at a safe temperature to drink. The group also noticed a current rise in "smart devices" and people utilizing such devices to enhance their

lives. Examples such as smartwatches and fitness trackers allow people to keep track of their health, how much physical activity they've received in a day, and so much more. From 2013 to 2014 there has been an 82% increase in smartwatch sales. Fitness trackers on the other hand had a massive 500% percent increase from 2013 to 2014. Both these devices are capitalizing on the health/fitness market that is currently booming and continues to grow.

The Nepton is a "smart thermos" that will not only enhance how people consume their beverages with its ground-breaking temperature customization options and temperature-sensitive e-ink outer layer, but also has numerous health benefits by preventing users from drinking overly hot beverages that may scald their tongues or mouths. The American Cancer Society has talked about a well established relationship between esophageal cancer and drinking very hot drinks. The Nepton is automatically calibrated to warn users when they've reached too high of a temperature so users will know when their health might be at risk. The Nepton is a simple but significant improvement to people's everyday lives, and is the all-in-one package for the health-oriented and digitally-connected consumer that is currently on the rise.

Prototyping

A. Product Concept

The design of the Nepton was based on simplicity. The Nepton looks clean and modern, and marriages function and form at every angle. The main body is a curved cylinder for a sleek yet ergonomic design. It measures roughly 10 inches tall with a 3 inch diameter. At the bottom are angled slits to help vent heat from the internal components.

The internal components, starting from the bottom of the thermos, consist of the battery, a layer of insulation, and the electronics. A heat sink wraps around all of these items and transfers excess heat away from the battery and electronics.

The vacuum-enclosed inner-cup, which holds up to 16oz. of liquid, fits snugly into the main body of the thermos. The lid, which contains the heating rod, will have a metallic contact that will allow energy to transfer through from the battery. The lid also features a convenient one-push flip-up design for easy one-handed operation.

ACCEPTANCE CRITERIA FROM CONSUMER NEED:

AC-1: The Nepton shall be portable and convenient for use in transit and weight no more than 3 pounds.

AC-2 :The Nepton shall seal the beverage with O-rings and be made with material that can withstand temperatures of 200 degrees F without harm to its users.

AC-3: The Nepton shall be made from brushed aluminum and stainless steel, e-ink panels, and clear plastic.

AC-4: The Nepton shall use an e-ink panel to inform the users about the temperature of the beverage, and use a phone application to adjust and calibrate the temperature.

AC-5: The Nepton shall have a standby battery life of 12 hours and a continued use battery life of 2 hours using rechargeable batteries and will have a lifespan of 2 years.

1.0 SYSTEM OVERVIEW

2.0 REQUIREMENTS

2.1 Functional Requirements

2.1.1 Input Requirements

2.1.1.1 The Nepton system shall accept the Nepton's lid from the customer.

2.1.1.2 The Nepton system shall accept the "Beverage Name" from the customer.

2.1.1.3 The Nepton system shall accept the customer's request to reheat the beverage.

2.1.1.4 The Nepton system shall accept a "Perfect Temperature Recalibration Request" from the customer.

2.1.1.5 The Nepton system shall accept the customer's new "Perfect Temperature Recalibration".

2.1.1.6 The Nepton system shall accept the removable inner cup.

2.1.1.7 The Nepton system shall accept the Battery charger from the customer.

2.1.2 Output Requirements:

2.1.2.1 The Nepton system shall provide the Nepton's lid to the customer.

2.1.2.2 The Nepton system shall provide a request for the "Beverage Name" to the customer.

2.1.2.3 The Nepton system shall provide a beverage temperature notification of "Too Cold" to the customer.

2.1.2.4 The Nepton system shall provide a beverage temperature notification of “Too Hot” to the customer.

2.1.2.5 The Nepton system shall provide a beverage temperature notification of “Perfect” to the customer.

2.1.2.6 The Nepton system shall provide a request for the new “Perfect Temperature Recalibration Request” to the customer.

2.1.2.7 The Nepton system shall provide a warning to the customer concerning the temperature boundaries when

2.1.2.8 The Nepton system shall provide a confirmation to the customer that the new “Perfect Temperature Recalibration” has been set.

2.1.2.9 The Nepton system shall provide the unattached inner cup to the customer.

2.1.2.10 The Nepton system shall provide the inner cup reattached to the Nepton to the customer.

2.1.2.11 The Nepton system shall provide a visual indicating low battery life to the customer.

2.1.2.12 The Nepton system shall provide a visual indicating that the Nepton is currently charging to the customer.

2.1.2.13 The Nepton system shall provide a visual indicating that the Nepton is finished charging to the customer.

2.1.3 Interface Requirements

2.1.3.1 The Nepton system shall provide an easily navigable user interface.

2.1.3.2 The Nepton system shall insulate heat sensitive components from heat generating components.

2.1.3.3 The Nepton system shall require that the container surface touching the beverage be removable for safer cleaning.

2.1.3.4 The Nepton system shall accept user recalibrations to pre-set perfect temperatures.

2.1.3.5 The Nepton system shall accept user changes to temperature notifying patterns.

2.1.4 Operational Requirements

2.1.4.1 The Nepton system shall reheat the beverage inside of it.

2.1.4.2 The Nepton system shall accept customer requests and provide feedback.

2.1.4.3 The Nepton system shall determine Nepton’s response to inputs received.

2.1.4.4 The Nepton system shall make carrying the Nepton convenient.

2.1.4.5 The Nepton system shall notify the user of the current temperature of the beverage inside it in relation to the calibrated perfect temperature.

2.1.4.6 The Nepton system shall connect wirelessly to the user's smartphone.

2.1.4.7 The Nepton system shall measure the current temperature of the beverage inside it.

2.2 Non-Functional Requirements

2.2.1 Physical Requirements

2.2.1.1 The Nepton system shall maintain a weight less than 2 pounds.

2.2.1.2 The Nepton system shall maintain a height of less than 15 inches but greater than 10 inches.

2.2.1.3 The Nepton system shall have a widest diameter of between 3 and 4 inches.

2.2.1.4 The Nepton system shall utilize a push-button lid deploying system.

2.2.1.5 The Nepton system shall utilize a hinge for the lid.

2.2.1.6 The Nepton system shall provide a means to carry the container conveniently.

2.2.2 Technology Requirements

2.2.2.1 The Nepton system shall utilize thermocouple temperature sensing capabilities.

2.2.2.2 The Nepton system shall incorporate O-rings leak prevention technology.

2.2.2.3 The Nepton system shall incorporate Bluetooth technology.

2.2.2.4 The Nepton system shall incorporate a round-the-thermos e-ink display.

2.2.2.5 The Nepton system shall utilize heating coil heating capabilities.

2.2.2.6 The Nepton system shall utilize battery power when not plugged in.

2.2.2.7 The Nepton system utilize the user's existing smartphone IOS.

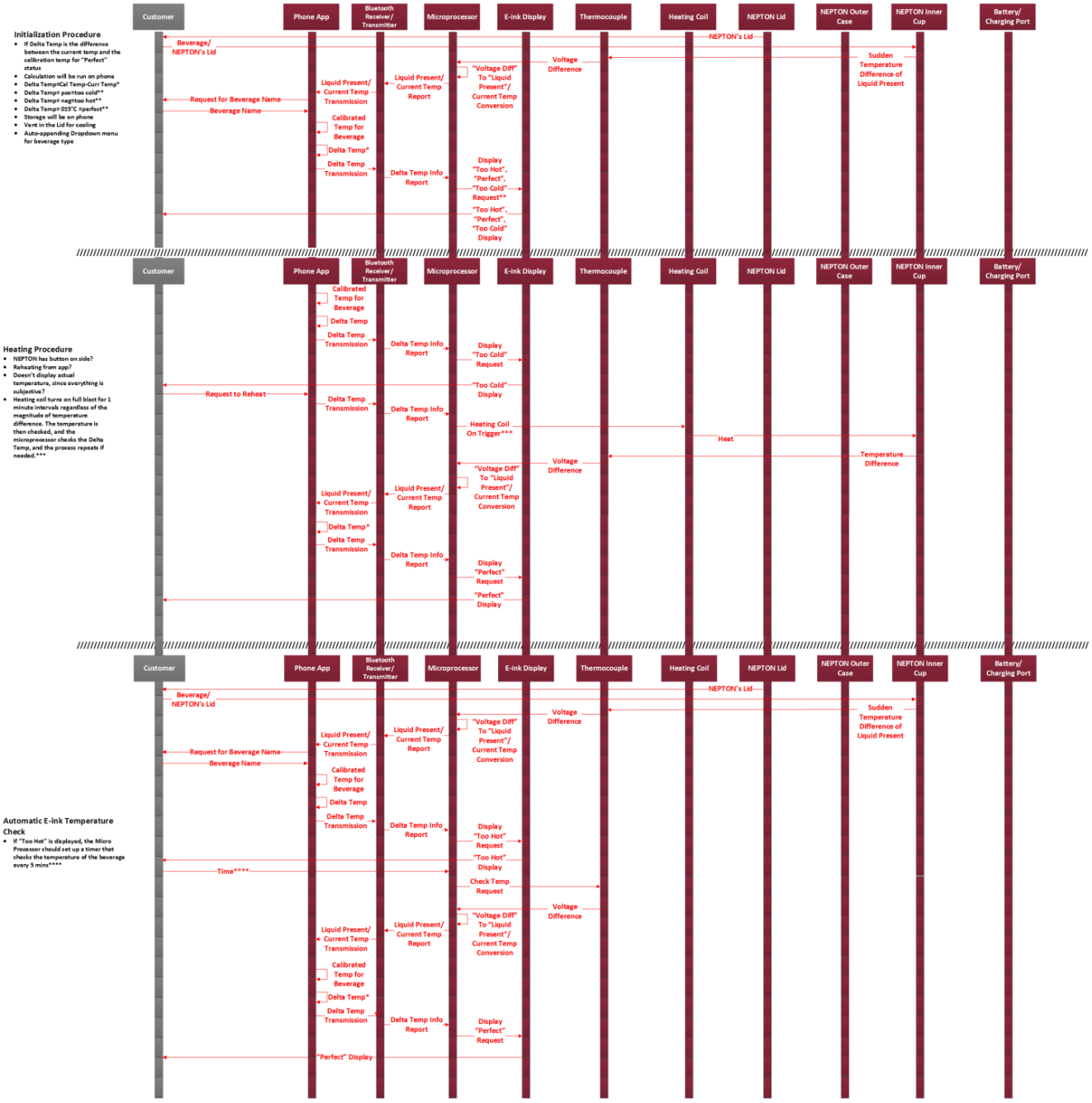
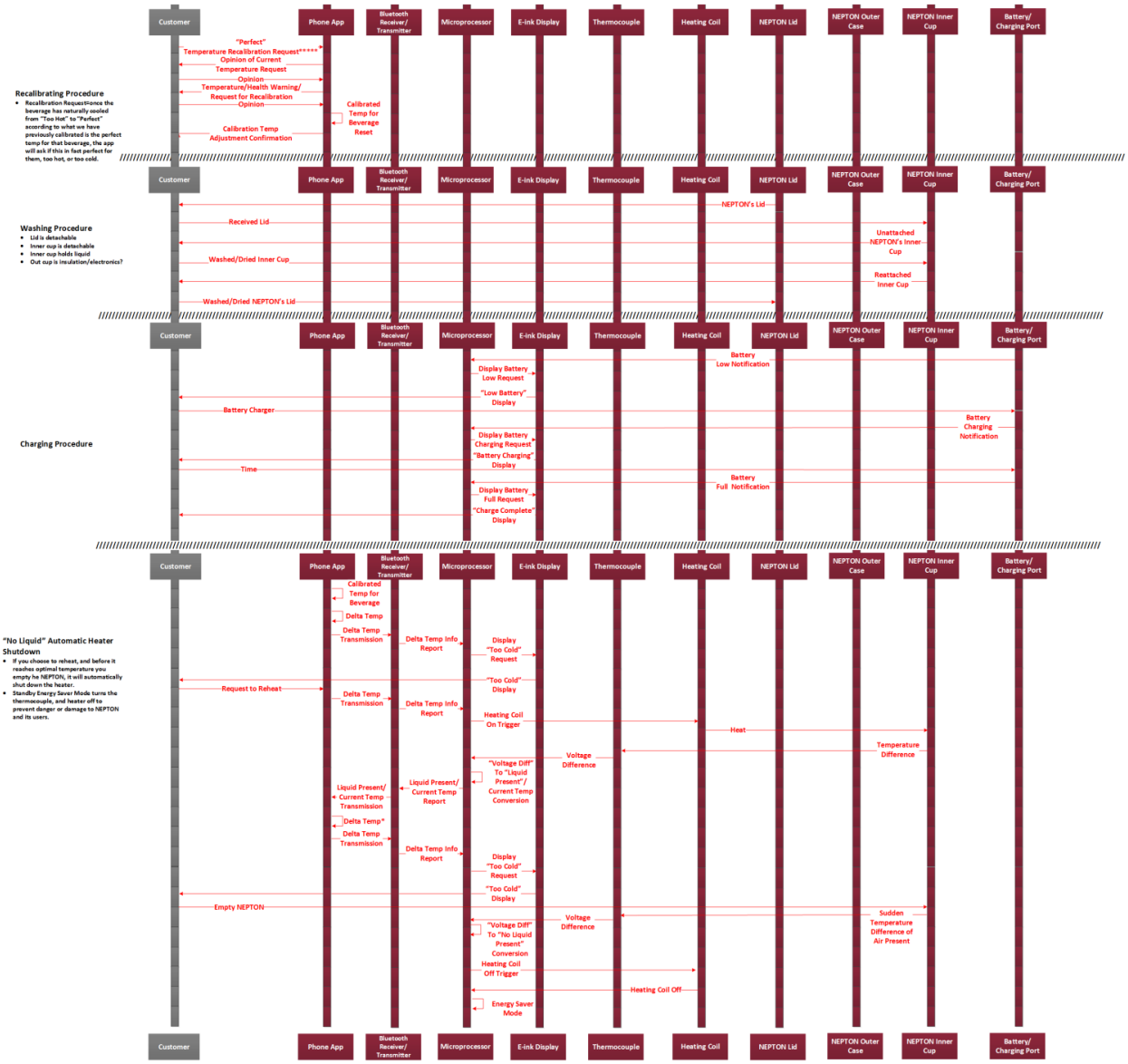


Figure 5: Use Cases (1st Level)



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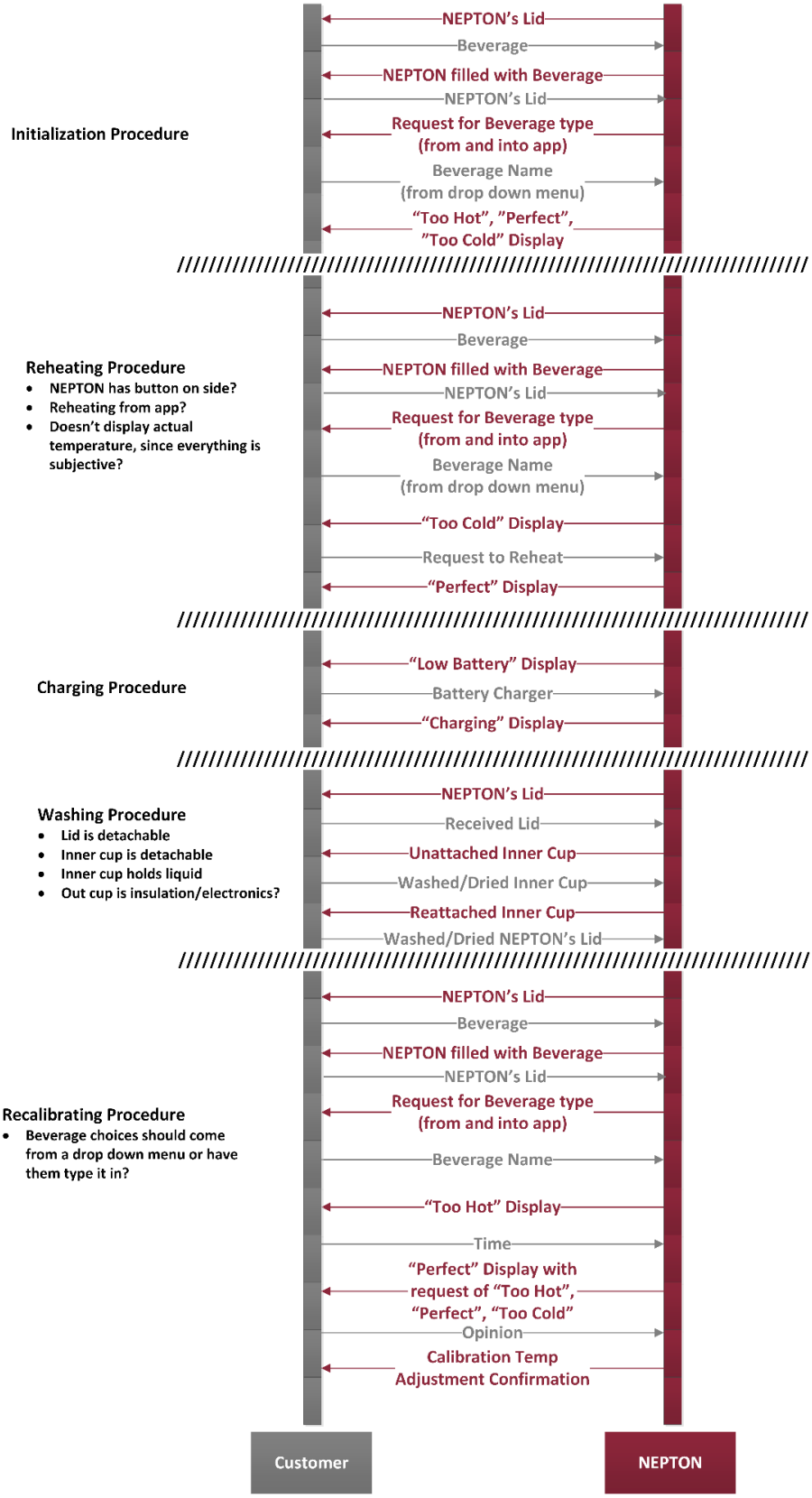


Figure 6: Use Cases (External)

B. How the Prototype Works

Currently the prototype is in its alpha stage. Things that still need to be changed include the placing all the electronics that control the Nepton inside the case, the E-ink notifier is only 3 by 2 inches, and it all currently runs on AC power from a wall outlet. Clearly, it is not ready for the market. However, even given the limited time and budget, the prototype is completely functional and the team is prepared to finish the Nepton to market ready standards. Our group has made plans to address all the issue with the current prototype in order to create a completely functional, aesthetic, finished product.

A major feature of the current prototype that needs to be changed is the dependence on external power. As mentioned before, the current prototype depends on AC power from a wall outlet. The group has designed the final prototype to utilize a custom lithium manganese oxide battery to deliver 6,000 mAh. To address any potential heating issue with the battery, the team is also utilizing a heat sink that will fit around the battery, and insulation between the electronics and the battery. All the electronics that are outside of the product would be placed inside a special 3D printed case extension. This will safely house not only the electronics that are currently outside of the product, but also the future battery, heat sink, and insulation as well. This makes the final prototype much more convenient as it makes for a more portable Nepton.

The current prototype also has two wires extending from the cap of the Nepton. The first is the wire for the heating coil, and the next is the wire for the temperature sensor. These two wires will not be threaded through the cap. Instead, the group has developed a metal contacts system on the outside threads of the cap and the inside threads of the cup. The wires will then be wired down beneath the e-ink. The e-ink will also cover the entire outside of the cup, rather than just being a 3 by 2 inch square.

Since the prototype is still fully functioning, a description of what each components is and how it was implemented can be found below. Major components discussed include the companion application, the control board, the temperature sensor, e-ink notifier, heating coil, 3D printed extension, and general changes to the cap.

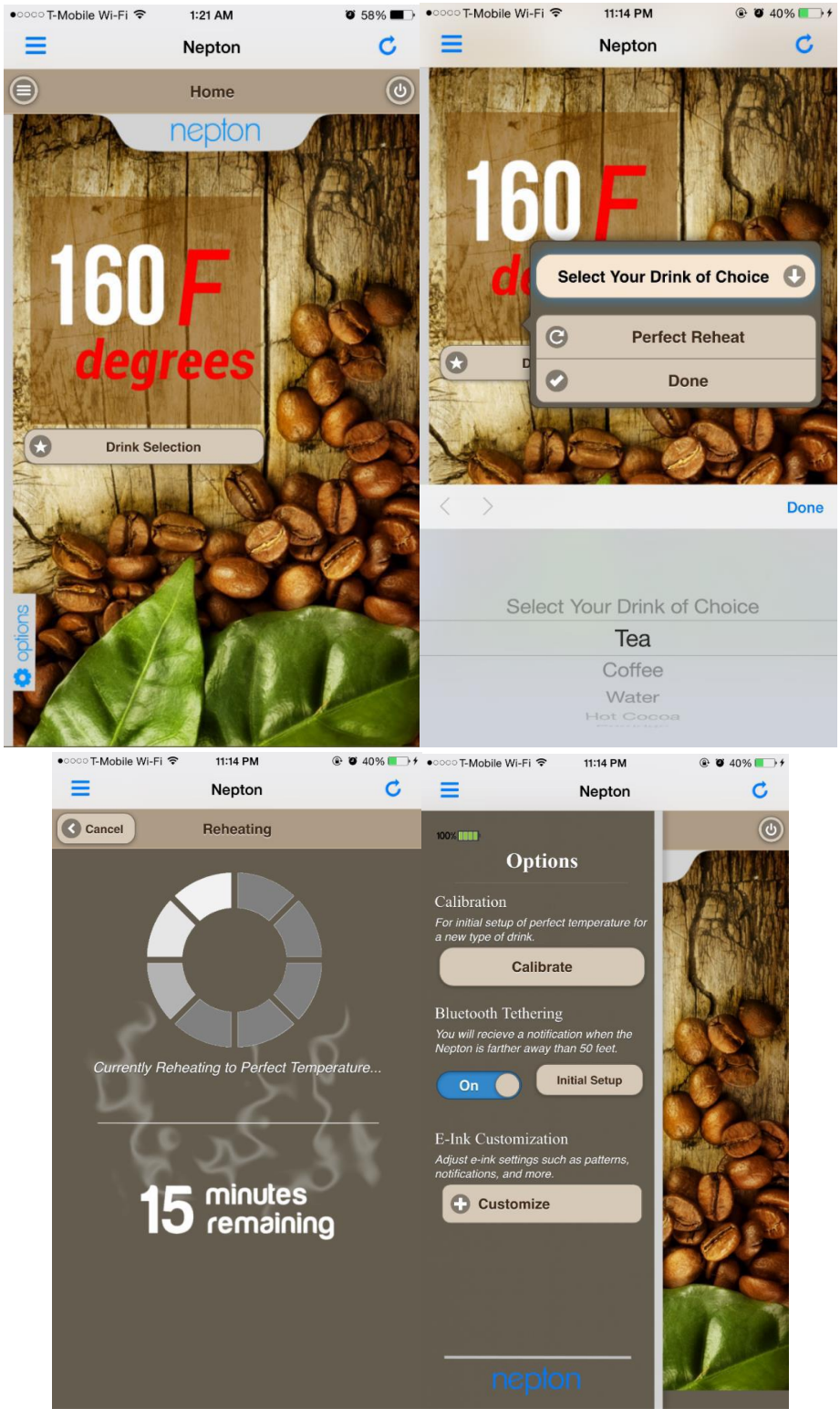
Companion Application:

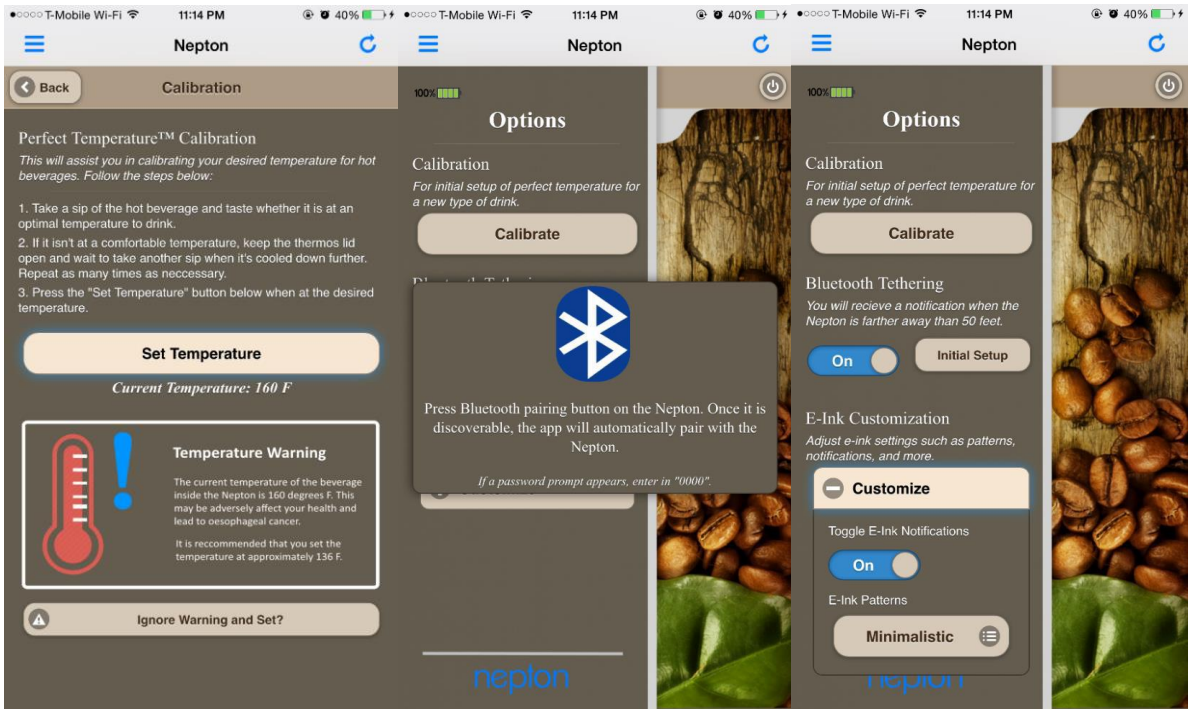
The Nepton application will be developed for iOS for all iPhones. The app will allowed the digitally connected consumer to control all the technical features of the thermos as well as display information such as battery life. The final app will be programmed in Swift, to take advantage of the new and improved graphics, speed and safety improvements, and the new interactive playground. The app will connect and pair to the Nepton via Bluetooth. For the prototype, the demo app was created via Appery.io and has the following layout:

Structure and Features

1.0 Home (Page)
- 1.1 Power Button (Button)
  - 1.1.1 Turn on Nepton
- 1.2 Side Options Menu (Side Panel)
  - 1.2.1 Swipe or click side menu button to activate
  - 1.2.2 Display current Nepton charge
  - 1.2.3 Calibration
    - 1.2.3.1 Calibrate “Perfect Temperature” for a new drink
    - 1.2.3.2 Warn if temperature set is above recommended temperature to mitigate risk of esophageal cancer
      - 1.2.3.2.1 Ignore warning if desired
  - 1.2.4 Bluetooth Tethering
    - 1.2.4.1 Toggle Bluetooth tethering
    - 1.2.4.2 Initially pair app and Nepton
  - 1.2.5 E-Ink Customization
    - 1.2.5.1 Toggle e-ink notifications
    - 1.2.5.2 Select e-ink design
- 1.3 Current Nepton Temperature Display (Feature)
  - 1.3.1 Display current beverage temperature inside Nepton
- 1.4 Drink Selection (Popup)
  - 1.4.1 Select drink to set Perfect Temperature reading
  - 1.4.2 Perfect Reheat
    - 1.4.2.1 Heat drink to Perfect Temperature

Figure 7: Application Screenshots





Heating Coil:

The objective of the heating coil is to increase the temperature from of the liquid inside of the body of the Nepton from 25°C to 54.44°C. 25°C is taken as room temperature, which equates to 77°F, and 54.44°C is taken as 130°F, which is the optimal "safe temperature" at which to drink tea. The team had to determine the amount of energy required to create this temperature difference to see if it was there was a heating coil that could heat this much. Below are the calculations as to the amount of energy required, as well as the energy deliverable with the custom battery the group planned to use in the final project.

Assumptions:

1. The liquid is water (coffee, tea, and other beverages are largely water-based)
2. The container is perfectly insulated (no heat loss from conduction, convection, or radiation)
3. The container is a closed system (no mass enters in or out of the system)

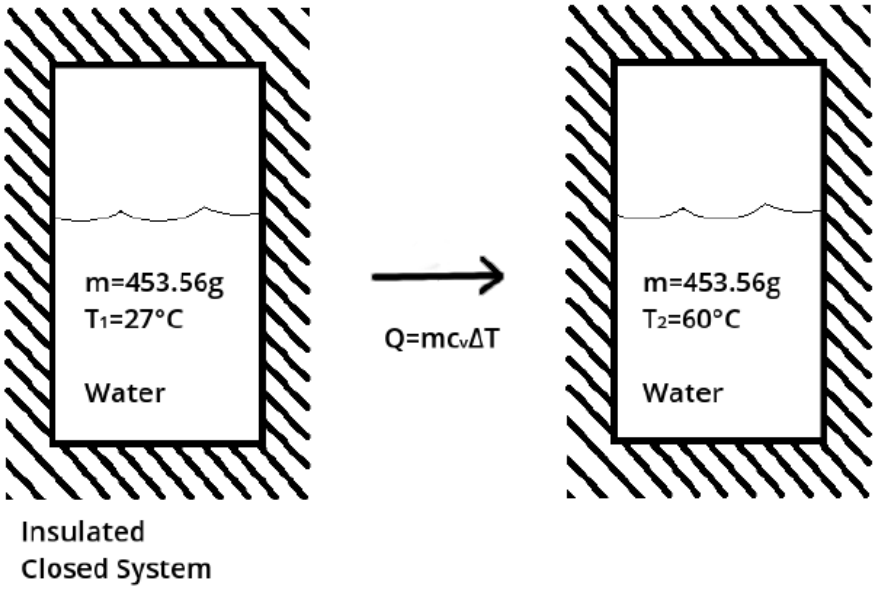


Figure 8: Heating Coil Proof of Concept

Energy Required:

$Q = mc_v\Delta T$

m = 16oz = 453.56g (mass of water)

T_1 = 25°C (room temperature)

T_2 = 54.44°C (target temperature)

c_v = 4.186 kJ/kg°C (specific heat of water, constant volume)

Q = 0.45356 × 4.186 × (54.44 - 25)

Q = 55.89 kJ

Energy Delivered:

Battery Capacity = 6,000 mAh (can provide 10 amperes of current for 1 hour)

P = IV (Watts)

V = 8.4V

I = 6A

P = 6 × 8.4 = 84 W = 50.4 J/sec

$E = P\Delta t$ = 50.4 × 3600 = 181440 J

E = 181.440 kJ

Rate of Heat Transfer:

The selected battery of choice is a custom lithium manganese oxide (LMO). The battery is rechargeable and has a significantly higher energy density than standard lithium-ion batteries, meaning that it can provide current at a significantly

higher rate. Nepton will utilize a 6,000 mAh LMO with a maximum current discharge of 6A.
V = 8.4V
I = 6A
P = 8.4 × 6 = 50.4W = 50.4 J/sec
14
E = 55890 J
Δt = E / P = 55890 / 50.4
Δt = 1108.93 sec
Δt = 18.48 min

The heating coil requires electric power, and since the group's limited funds did not allow for the purchase a custom battery, the group kept the heating coil's wall plug. This would mean that the heating coil would plug into a wall outlet, while still being inside of a fully enclosed Nepton. This required boring three holes through the top piece: one through to the cup where the liquid would reside, one through the drinking lip, and one through the flip cap. This allowed a cord to be wired through and plugged into an outlet. The heating coil itself was then secured to the top piece, allowing for the top piece to be screwed on and off with the heating coil tightly secured in place.

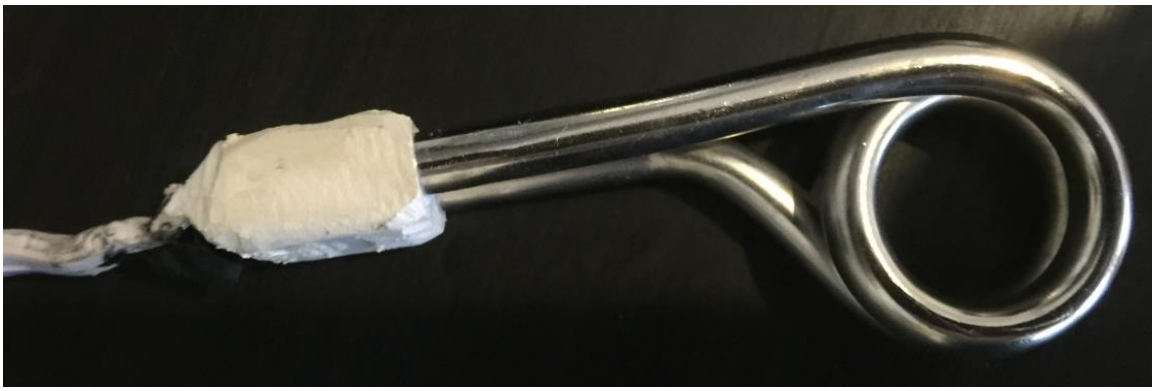


Figure 9: Modified Heating Coil

Figure 10: Modified Cap with Holes and wiring

Body/3D Printed Bottom:

The Nepton's exterior body and interior cup will be made out of stainless steel. A finned aluminum heat sink will be located on the bottom of the Nepton to draw excess heat generated by the battery away from the electronic internals. The heating coil is attached to the top of the Nepton and extends downwards into the interior cup, connected to the battery through metallic contacts. Electronic internals and the battery are located at the bottom of the Nepton. The e-ink exterior is surrounds the exterior body and is insulated from any heat generated from the heating coil and the battery.

NEPTON CAD MODEL

Figure 11: Isometric View

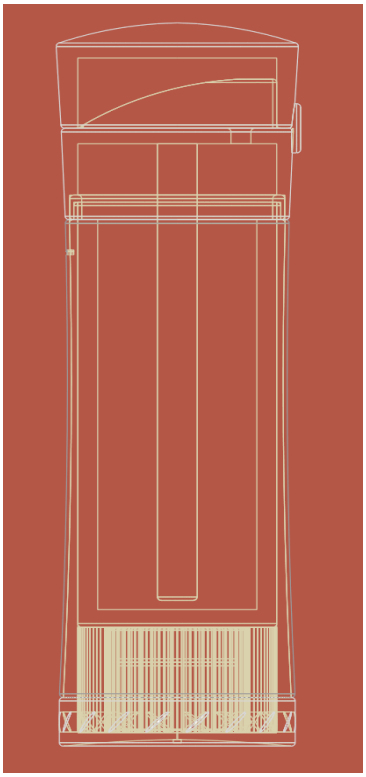


Figure 12: Right View

Figure 13: Top-down View

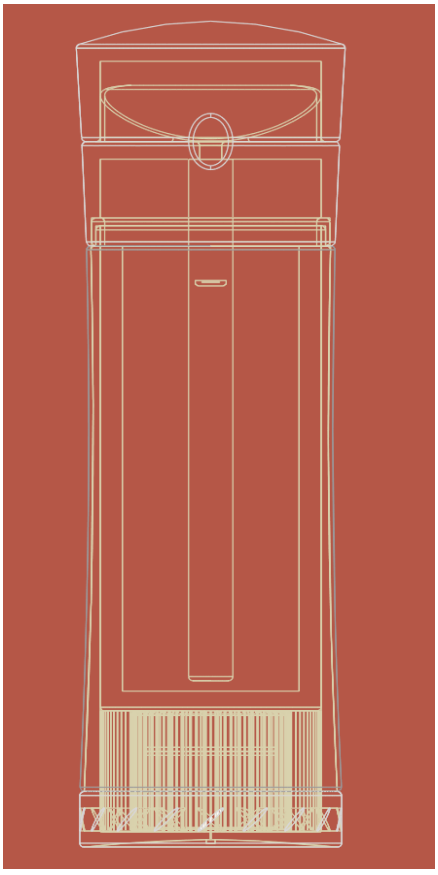


Figure 14: Front View

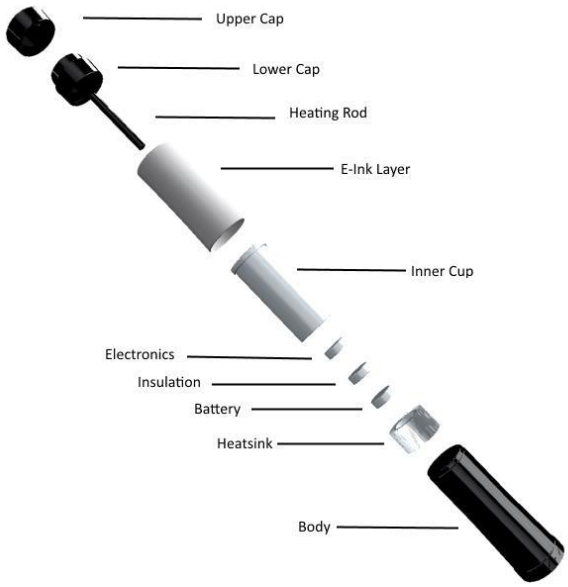


Figure 15: Exploded View

Figure 16: Full Render

The current prototype has all the internal components external. This make experimenting with potential configurations much easier, but it is also due to the fact that the current body is from an prefabricated thermos that does not meet the exact specifications of the Nepton. If the Nepton body were custom made, it would feature a longer body by at least 1 inch, and would house all the internal components, including a battery, control board, insulation and a heat sink. The version used in the prototype was 3D printed at Carnegie Laboratory at Stevens Institute of Technology. 3D printing technology allows for prototyping to be done quickly and easily for relatively simple geometries. The group had to first model the piece in a CAD program, and send the file to the 3D printer. The printer then slices the piece into 2D slices, and “prints” a layer at a time until a full 3D piece is created. This piece was one of the few components that the group was able to custom manufacture. It allows for onlookers to visualize what the finished height of the final project would look like.

Figure 17: 3D printed Case Extension

Temperature Sensor:

The objective for the temperature sensor was to be able to implement a means to be able to read the immediate temperature inside the Nepton. This temperature is leveraged to perform many of the Nepton's control functionality, such as automatic heating shut off, changing the E-Ink screen to the appropriate gradient, and temperature calibration. For our prototype, the team had utilized a waterproof DS18B20 temperature sensor and inserted it through our modified cap as seen in pictures below. In terms of connecting the temperature sensor to the Raspberry Pi, we wire it to a breadboard with a 4.7k resistor and connect via GPIO pin 27. We leverage the W1ThermSensor python library to parse and read the incoming temperature data.

Figure 18: Modified Cap with Holes and wiring

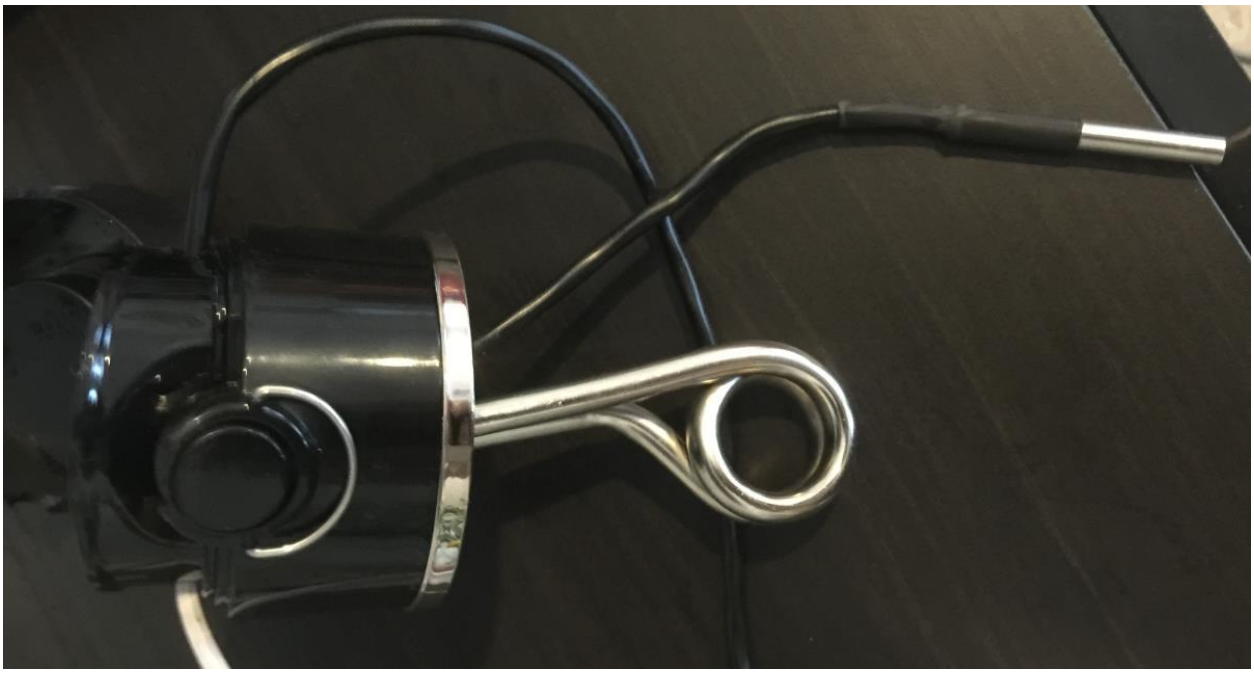


Figure 19: Modified Cap with Heating Coil and Temperature Sensor

Raspberry Pi:

The objective for the Raspberry Pi is to act as a microcontroller to control all functionality of Nepton. For a market ready Nepton, this microcontroller would be a customized one that is significantly smaller than the Raspberry Pi. The Raspberry Pi is much larger because it is meant to be a general purpose processor. In our prototype, which can be seen below, the Raspberry Pi is powered by a micro-USB cable, has a wireless USB dongle to allow us to remote into the system, and utilizes the majority of the GPIO pins. The E-Ink screen attaches to the Pi through 26 pins and the rest of the pins are utilized for buttons, the solid state relay (SSR), and the temperature sensor. The heating element is not directly attached to the Pi but is controlled by it. The heating element is attached to an extension cord that has had it's hotwire side snipped. The snipped ends had ring terminals installed and these were installed on the SSR.The SSR acts as an electromagnetic switch that turns the heating element on and off, allowing electricity to flow in or vice-versa. The actual Nepton program that controls our product is also housed inside the Pi and is written in Python.

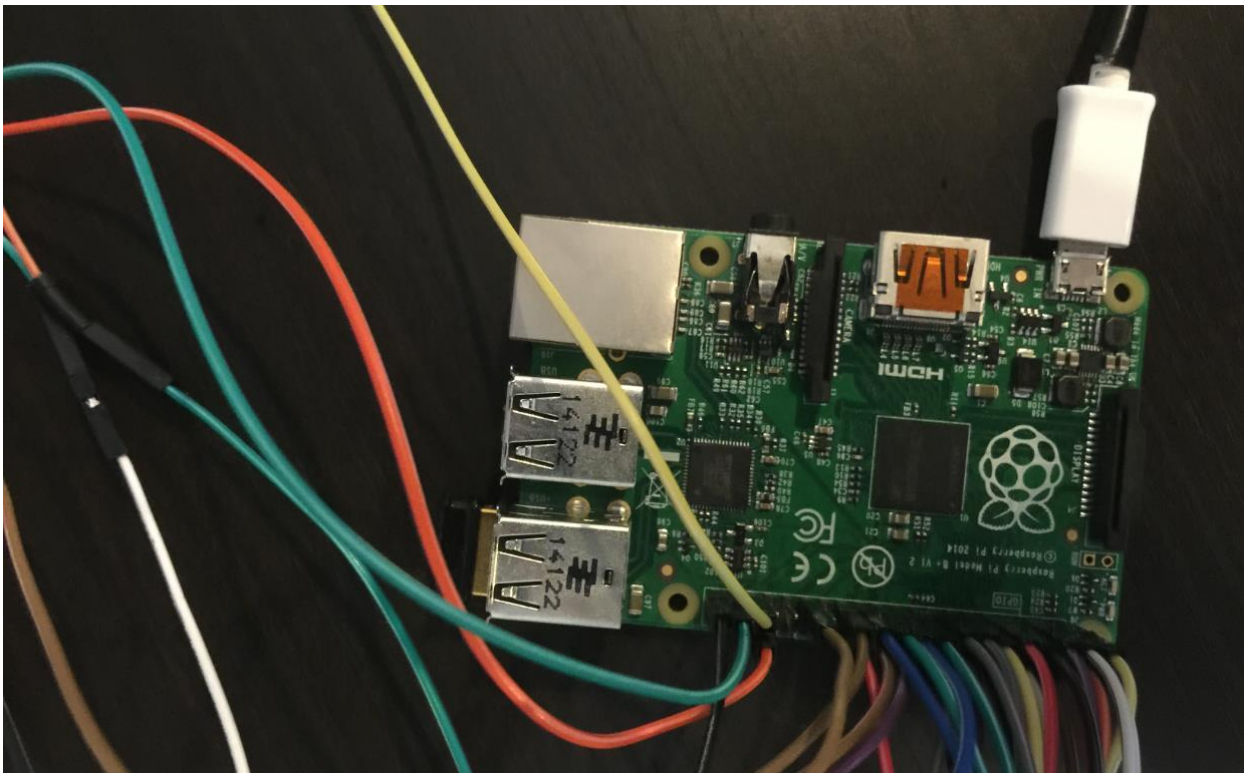


Figure 20: Raspberry Pi

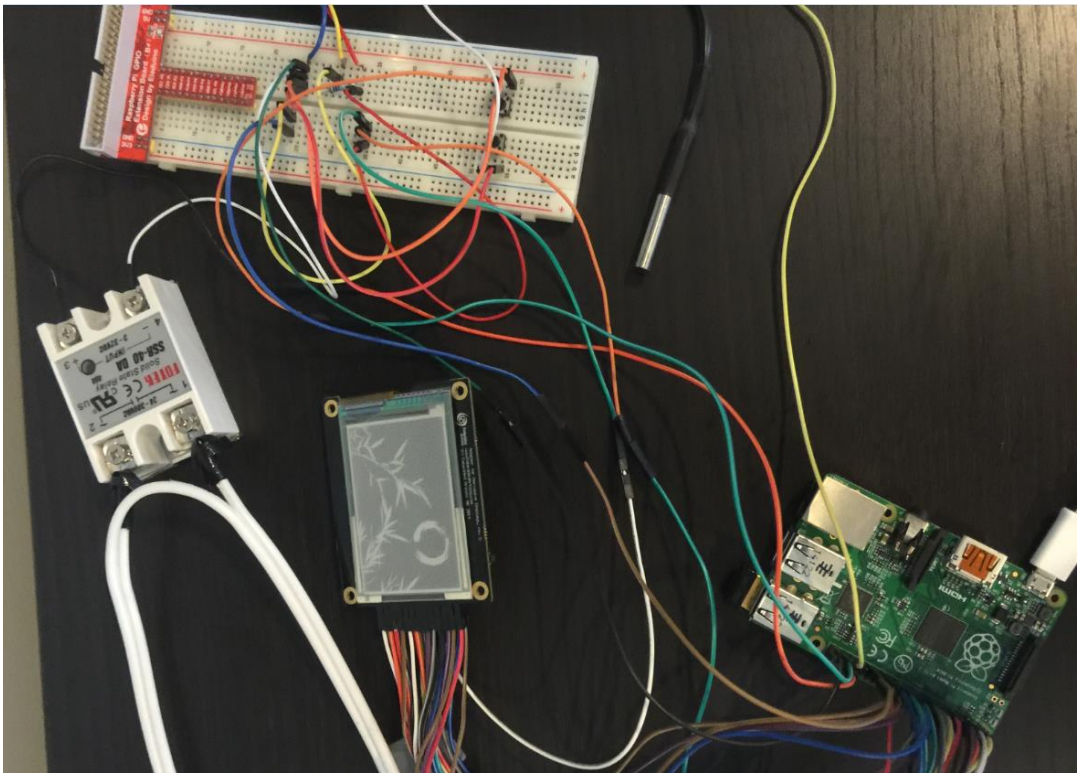


Figure 21: Raspberry Pi with E-ink Notifier

E-Ink Notifier:

The objective of the E-Ink notifier is to indicate the current temperature of the liquid inside of the Nepton respective to the user calibrated temperature. With the market-ready Nepton, the E-Ink display would be a flexible screen that would cover and wrap around the entire Nepton body. In our prototype however, due to financial considerations, decided to demonstrate the functionality through an Embedded Artists 2.7 in. E-Ink screen. This screen is hooked up to the Raspberry Pi directly through its 26 pin connection. The E-Ink screen is controlled by the Pi via the main Python code that leverages the Gratis Python library. The E-Ink screen displays two patterns, Nature and Waves, each consisting of five gradients. Each of the gradients represent a temperature range: Very Cold, Cold, Just Right, Hot, and Very Hot. The cold range gradients will be lighter with Very Cold being the lightest and the hot range gradients will be darker, with Very Hot being the darkest. Below for reference are a close up of the screen as well as a photo of how everything is connected.

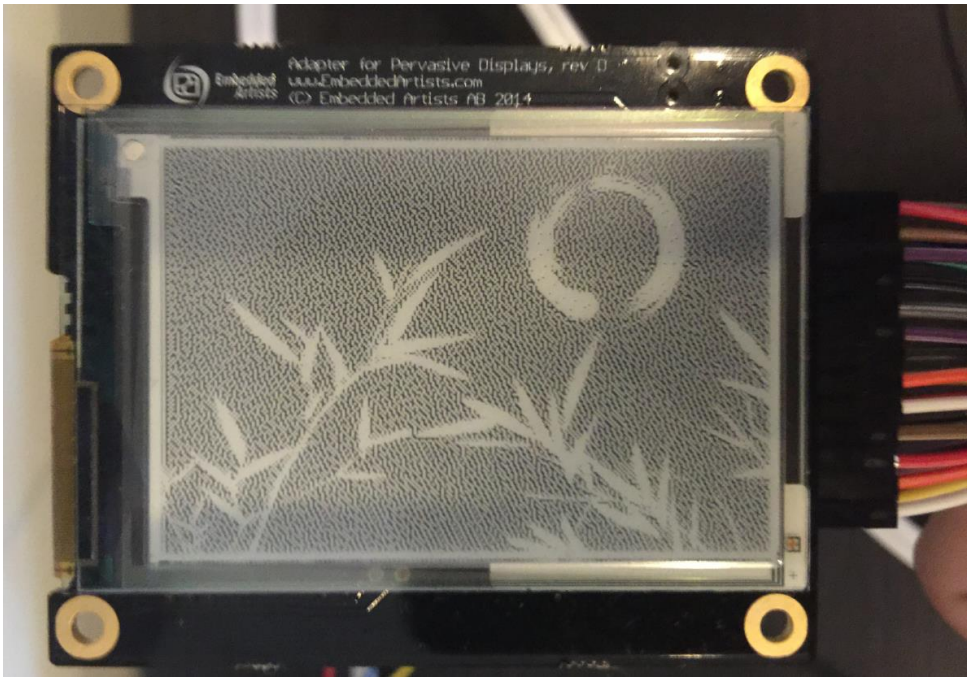


Figure 22: E-ink Notifier

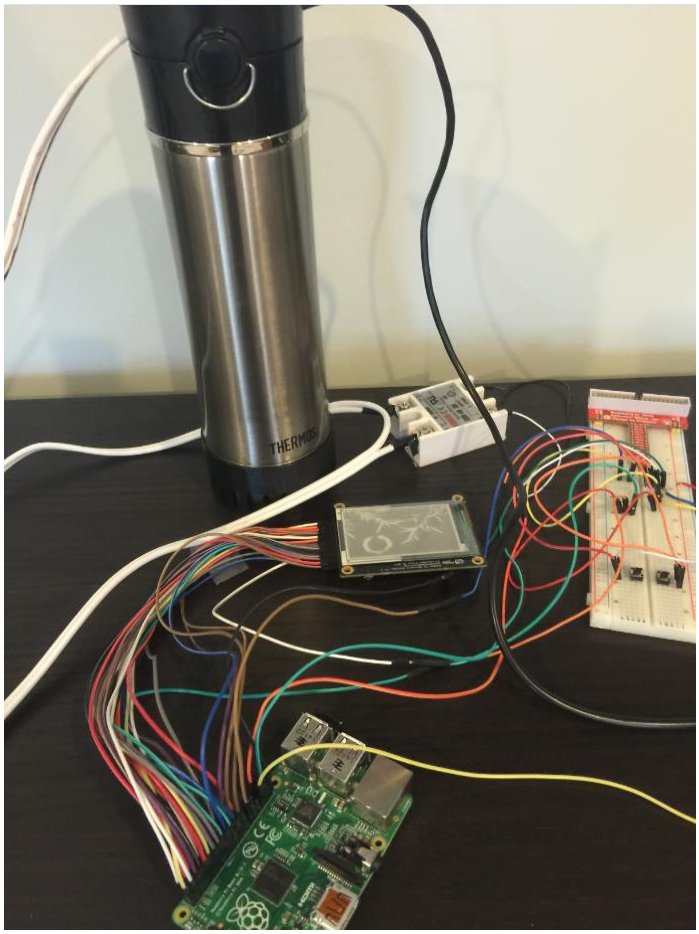


Figure 23: Final Prototype Set up

C. Prototype Technology Delivers Consumer Need

1. COMPANION APP

Consumer Need:

Control, calibrate, and individualize Nepton's functional and aesthetic settings through an intuitive and easy to use interface.

Summary:

Consumers today expect and demand a certain degree of quality, complexity, and control within their products. Quality in that they can expect the product to work out of the box reasonably well, complexity in that the product is versatile and has multiple functions, and control in that they can adjust the product to best suit their individual preferences or needs. The Nepton team believes that the inclusion of an app fulfills a modern digital

consumer's expectations of a technological link in all the aspects mentioned above.

Although the Nepton requires an app in order to function to its full potential, its inclusion is so that consumers have access to adjust Nepton in an intuitive way. Rather than putting temperature calibration, battery life, and heating settings, and other such functions on the physical Nepton, such controls are all included within the app. Including the number of buttons and dials needed to fully control Nepton would not only decrease the portability and aesthetic of Nepton, but also increase the difficulty of using it. The app includes easy to follow instructions that allow the Nepton to function normally out of the box.

Including an app allows the Nepton to be significantly more complex from a feature and functionality standpoint. By shifting data processing and storage to the smartphone, Nepton retains the portability of a beverage container while still having the complexity of a "smart" product. Features such as temperature calibration, drink settings, and body aesthetic modifications would not be possible without the inclusion of an app to handle the raw data processing required.

While the Nepton itself is significantly more complex than its competitors from a features and functionality standpoint, the Nepton team ensures that this complexity is not translated back to the consumer. Almost every function of the cup is adjustable to the individual needs and preferences of the user. Users will not need to hunt down settings in the app's back end, but will be initially greeted with a welcome screen that quickly points out where and how to adjust different functions within the app.

2. BODY

Consumer Need:

A durable, convenient, and vacuum-insulated container to store liquids in.

Summary:

While thermoses already exist to cater to all our optimal temperature beverage needs, the Nepton takes this technology and brings it to the cutting edge. Underneath the innovative e-ink exterior lies the foundational core of the Nepton. The body is crafted from a tough and lightweight stainless-steel which means the product will stand up to drops and dings, and is easy to travel with. The material also allows the exterior surface to maintain a comfortable temperature, so it can always be held no matter how hot the liquid inside may be. Furthermore, stainless-steel will not affect the taste of your beverage, making sure your drinks always taste as they should. And since the container is vacuum sealed, beverages can maintain their temperature (hot OR cold) for up to 24 hours, without even having to utilize our revolutionary heating element.

The container also holds up to 16oz. so you'll always be sure to have the right amount of beverage with you. The lid also features a simple one-handed push-to-open top that is also 100% leak-proof. Not to mention our convenient flip-up ring for those who want to clip their Nepton's to their bags and have their hands free for other tasks.

3. E-INK NOTIFIER

Consumer Need:

Inform about the temperature of the beverage it contains in an understandable and applicable medium.

Summary:

One problem that hot beverage drinkers everywhere will agree with is that when their hot beverage is poured into a thermos or other covered drinking container, it is almost impossible to tell if the liquid inside has cooled enough to safely drink. Often, after misjudging the time that has passed, one will drink from the thermos and severely burn their lips, tongue and throats. The only solution is to wait for the drink to cool an enjoyable temperature and drink the beverage then. However, the average person doesn't live a slow, sedentary lifestyle that affords them the time to be constantly checking whether they can drink their beverages or not. Often they will just leave their beverage to cool, and forget about it, missing the

opportunity to experience and partake in the enjoyment that comes with consuming a warm beverage at the intended comfortable temperature that they so very deserve.The Nepton addresses these issues in earnest through it's E-ink temperature notification system.

4. HEATING ROD

Consumer Need:

Maintain drink temperature or heat up drink without home equipment.

Summary:

Although thermoses are efficient at retaining heat, as more of the liquid contained inside is drunk, the liquid is bound to lose the precious heat one hopes to preserve. A warm or hot drink is meant to be drank as the name specifies, hot or warm. These drinks, while delicious and invoke that warm fuzzy feeling while at their intended temperature, can lose their charm when the temperature drops. Hot cocoa on a frosty Christmas morning provides children and adults with a comforting warmth when hot but quickly loses appeal when the drink turns cold. Certain drinks are simply meant to be consumed hot and warm.

For those with active lifestyles and also enjoy a warm refreshment on the go, a thermos unfortunately does not typically satisfy their thirst when they are away from home. When your delicious drink is depleted, you are mostly out of luck for a hot refill unless there is a method of reheating nearby. One of the beauties of tea, one of the planet's most popular drinks, is that it is simple and quick to concoct. All that is needed is a tea bag and a hot cup of water. As with many other hot drinks, tea is traditionally served warm. Procuring a tea bag is not difficult and can be brought along with little difficulty. Obtaining hot water away from home however is another story.

The Nepton addresses both these issues in earnest through it's proprietary heating mechanism. The mechanism was designed with convenience in mind and will be powered by a custom rechargeable 6000 mAh Li-LMO battery with a nominal voltage of 8.4 V. The heating mechanism

is a heating rod that stems from the cover and sticks into the inner cup of the Nepton.

5. TEMPERATURE SENSOR

Consumer Need:

Measure the temperature for other applications.

Summary:

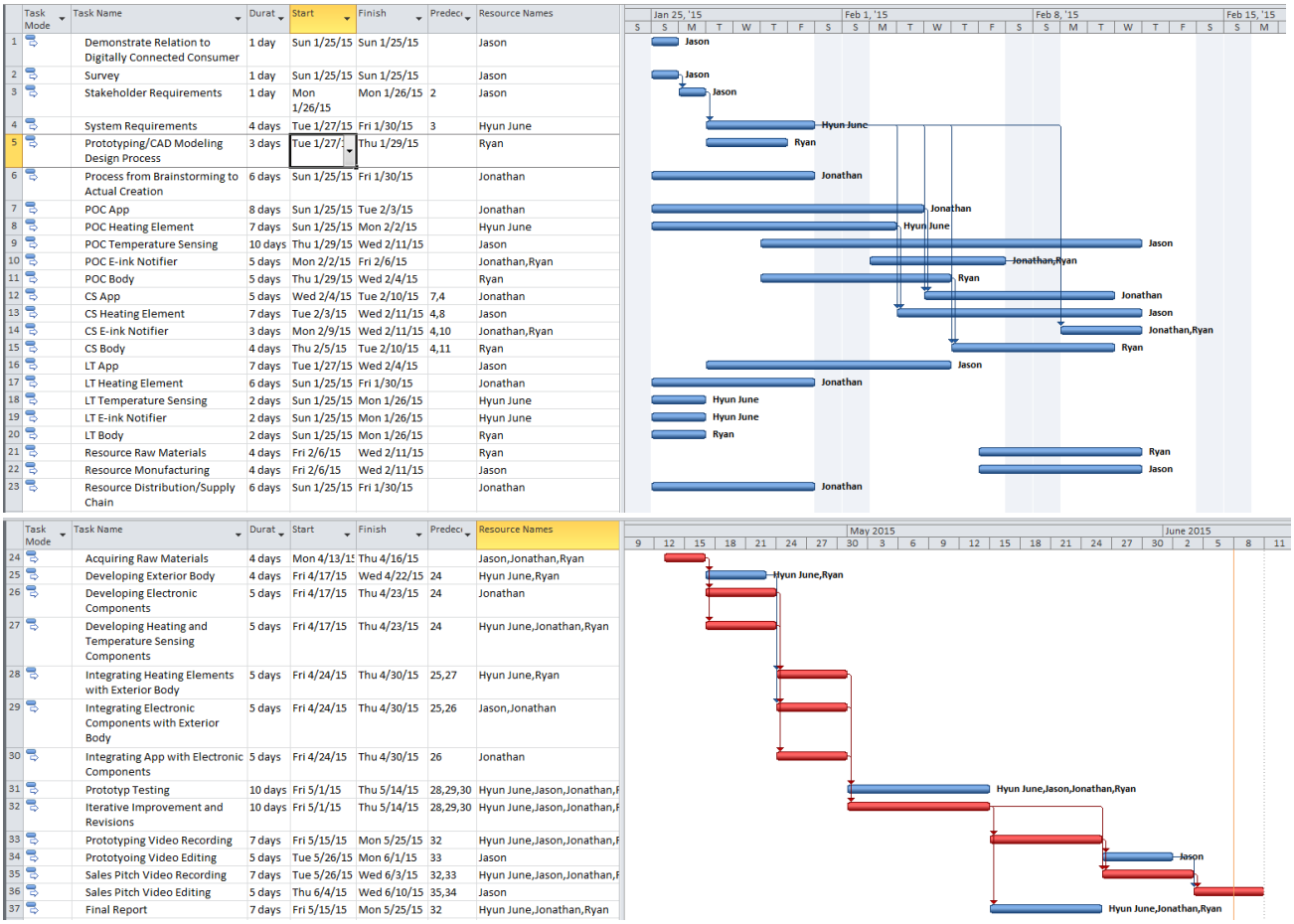
Temperature is the name of the game when it comes to thermoses and other heat retention beverage dispensers. Many thermoses are able to keep their beverage hot for a very long time. Through the vacuum insulation, it has been able to naturally maintain the original temperature of the beverages poured into it. However, for most thermoses, once the beverage is poured into the thermos, it is almost impossible to tell if the beverage is drinkable or not. Often, the natural heat retaining ability of the thermos is a drawback because it stays hot for too long, rendering the beverages inside inconsumable. Here we see a perfect example of the temperature creating a problem for the end user.

Another problem is that once the heat has been lost and the beverage has cooled to lukewarm bilge water, current thermoses have no way of making the beverages palatable again. The waste from beverages that have become subpar is avoidable if the beverage was able to be reheated. once again, there is an issue with the temperature, and without proper knowledge of what creates the problem, these issues can not be solved.

The Nepton addresses both these issues in earnest through it's added temperature sensing functionality. By utilizing time tested thermocouple technology, the Nepton is able to sense the current temperature of the beverage inside and relay that information for the customer to use. All temperature sensing is relative to the customer's unique and specific desires, so the temperature need of the end user are completely customizable. Using the temperature sensing ability, the Nepton is even able to sense when it is empty, a feature used reliably as a safety feature in the automatic heating mechanism shutdown.

Resources and Timeline

As shown in the Gantt chart below, the project was divided into two sections: the midterm and the final sections. The midterm section ran from January all the way through March, while the final section runs from April to June. The first section consisted mostly of planning and brainstorming, while the final section consisted of acquiring material and physical prototyping. All the major milestones such as reports, prototyping, integration and testing are clearly marked on the chart. The full schedule can be seen below.



	Task Mode	Task Name	Durat	Start	Finish	Predec	Resource Names
1		Demonstrate Relation to Digitally Connected Consumer	1 day	Sun 1/25/15	Sun 1/25/15		Jason
2		Survey	1 day	Sun 1/25/15	Sun 1/25/15		Jason
3		Stakeholder Requirements	1 day	Mon 1/26/15	Mon 1/26/15	2	Jason
4		System Requirements	4 days	Tue 1/27/15	Fri 1/30/15	3	Hyun June
5		Prototyping/CAD Modeling Design Process	3 days	Tue 1/27/1	Thu 1/29/15		Ryan
6		Process from Brainstorming to Actual Creation	6 days	Sun 1/25/15	Fri 1/30/15		Jonathan
7		POC App	8 days	Sun 1/25/15	Tue 2/3/15		Jonathan
8		POC Heating Element	7 days	Sun 1/25/15	Mon 2/2/15		Hyun June
9		POC Temperature Sensing	10 days	Thu 1/29/15	Wed 2/11/15		Jason
10		POC E-ink Notifier	5 days	Mon 2/2/15	Fri 2/6/15		Jonathan,Ryan
11		POC Body	5 days	Thu 1/29/15	Wed 2/4/15		Ryan
12		CS App	5 days	Wed 2/4/15	Tue 2/10/15	7,4	Jonathan
13		CS Heating Element	7 days	Tue 2/3/15	Wed 2/11/15	4,8	Jason
14		CS E-ink Notifier	3 days	Mon 2/9/15	Wed 2/11/15	4,10	Jonathan,Ryan
15		CS Body	4 days	Thu 2/5/15	Tue 2/10/15	4,11	Ryan
16		LT App	7 days	Tue 1/27/15	Wed 2/4/15		Jason
17		LT Heating Element	6 days	Sun 1/25/15	Fri 1/30/15		Jonathan
18		LT Temperature Sensing	2 days	Sun 1/25/15	Mon 1/26/15		Hyun June
19		LT E-ink Notifier	2 days	Sun 1/25/15	Mon 1/26/15		Hyun June
20		LT Body	2 days	Sun 1/25/15	Mon 1/26/15		Ryan
21		Resource Raw Materials	4 days	Fri 2/6/15	Wed 2/11/15		Ryan
22		Resource Monufacturing	4 days	Fri 2/6/15	Wed 2/11/15		Jason
23		Resource Distribution/Supply Chain	6 days	Sun 1/25/15	Fri 1/30/15		Jonathan
24		Acquiring Raw Materials	4 days	Mon 4/13/15	Thu 4/16/15		Jason,Jonathan,Ryan
25		Developing Exterior Body	4 days	Fri 4/17/15	Wed 4/22/15	24	Hyun June,Ryan
26		Developing Electronic Components	5 days	Fri 4/17/15	Thu 4/23/15	24	Jonathan
27		Developing Heating and Temperature Sensing Components	5 days	Fri 4/17/15	Thu 4/23/15	24	Hyun June,Jonathan,Ryan
28		Integrating Heating Elements with Exterior Body	5 days	Fri 4/24/15	Thu 4/30/15	25,27	Hyun June,Ryan
29		Integrating Electronic Components with Exterior Body	5 days	Fri 4/24/15	Thu 4/30/15	25,26	Jason,Jonathan
30		Integrating App with Electronic Components	5 days	Fri 4/24/15	Thu 4/30/15	26	Jonathan
31		Prototyp Testing	10 days	Fri 5/1/15	Thu 5/14/15	28,29,30	Hyun June,Jason,Jonathan,F
32		Iterative Improvement and Revisions	10 days	Fri 5/1/15	Thu 5/14/15	28,29,30	Hyun June,Jason,Jonathan,F
33		Prototyping Video Recording	7 days	Fri 5/15/15	Mon 5/25/15	32	Hyun June,Jason,Jonathan,F
34		Prototyoing Video Editing	5 days	Tue 5/26/15	Mon 6/1/15	33	Jason
35		Sales Pitch Video Recording	7 days	Tue 5/26/15	Wed 6/3/15	32,33	Hyun June,Jason,Jonathan,F
36		Sales Pitch Video Editing	5 days	Thu 6/4/15	Wed 6/10/15	35,34	Jason
37		Final Report	7 days	Fri 5/15/15	Mon 5/25/15	32	Hyun June,Jonathan,Ryan

Figure 24: Gantt Chart of Full Project Schedule

The team will try to use as many commercial over-the-counter to reduce extra costs and time spent manufacturing. Certain components will also be developed in-house, like the mobile application. Even using as many COTS as possible, many of the components will still have to be custom manufactured. A list of the necessary supply chain will consist of the materials shown in the chart below.

Components	COTS	Custom	In-House
Heating Coil		X	
Temperature Sensor	X		
E-ink Notifier		X	
Mobile Application			X
Microprocessor	X		
Li-Ion Battery		X	
Chassis		X	
Supplementary adhesives	X		
Heat Sink		X	
Insulation	X		
Wires	X		

Figure 25: Supply Chain for Final Product

In terms of what we would improve with $3000 in extra funding, we would be able to significantly up the quality of the prototype. The extra funding would allow us to purchase a custom, flexible E-Ink screen that could fit the entire thermos chassis, a custom 3-D printed cap, a custom heating element, a custom smaller microcontroller, and a Bluetooth module. The new custom parts that we would be able to custom order and manufacture would reduce significantly the overall size of the electronics and allow all the electronics to fit inside the custom 3D-printed heat sink located on the bottom of the thermos. The mobile app would also be able to communicate via Bluetooth to a smartphone. Naturally as this prototype would closer resemble a market-ready product, the overall aesthetics would also improve greatly.

Business Strategy

A. Market Plan

In terms of our branding strategy, we recognize that as a startup, our branding will be non-existent initially. We aim to build up our brand by marketing the Nepton as an easy to use alternative to current thermos that will revolutionize how hot drinks are consumed and capitalize on how it will be part of the growing Internet of Things as an smartphone connected device. In our marketing, we will aim to compare how current thermoses are inferior in functionality to our thermos in three main areas. Firstly, while other thermoses may be able to heat up your drink to a temperature, it does not maintain it. Secondly, while other thermoses provide their interpretation of “hot”, “cold”, and “just right”, ours allows the

customer to customize those temperature points to fit his or her sense of heat. Lastly, Other thermoses may be able to signal to the customer what temperature the liquid inside is through an exact reading, most users do not know intuitively that 54.4 C is the ideal hot beverage drinking temperature. The Nepton will instead inform the user that a drink is ready through an easy to comprehend pattern. Our marketing will be mainly concentrated on the internet through means such as Google Ads as a cheap but efficient way of spreading the word for our product.

B. Operations Plan

Different manufacturing methods can potentially yield different results. The different components that need to be custom manufactured include the heating coil, e-ink notifier, lithium ion battery, the heat sink, and the chassis. Given that all these pieces are relatively complex pieces, it is easier to break down the components into more specific parts. The heat sink is a single solid piece of material, which can be injection molded quite easily. However, the chassis requires a vacuum, and the aluminum must be stamped out of sheet aluminum and formed before vacuuming and sealing by welding. The heating coil's heating element can be injection molded, and the wiring inside it can be metal extruded and assembled after the pieces are completed. The lithium ion battery's different components, such as the electrodes, cells, and modules must be sized appropriately before being coated, compressed, and dried. The e-ink's electrodes must be shaped through injection molding and formed into concentric cylinders, and the pigments must be injected and sealed between the two. The pigments must also be polarized before injection.

Distribution will occur through both online retailers such as Amazon as well as brick and mortar consignment channels. The former allows a large amount of users while the latter will facilitate customers physical interaction with the product to inspect and demo. Initially distributing the Nepton through consignment channels such as Modell's to place the product into brick-and-mortar stores will allow for more physical viewing and generate more publicity. Beginning with consignment stores is to offset the fact that we are a startup. Consignment channels will be approached first as it allows a mutually beneficial relationship between the retailer and the supplier. It is a mutual relationship that allows us to place our product into a physical store while also allowing the vendor to assume less risk as they do not have to pay for the product until it sells. The supplier will be able to

showroom the product while the retailer does not pay for the product until it has sold. This will be a stepping stone to popularize the product. Once buyer confidence has been established, the retail scope will be expanded to include normal retail channels and we will aim to negotiate further contracts to sell the product.

C. Sales Plan

Based on the consumer research that the group conducted, the Nepton is targeted towards two group of people. The first is to individuals who own a thermos but feel that their hot beverage experience could be improved. The second is individuals who do not own or use a thermos. These people could be of any age, race, creed, or gender. The key defining factor are people who consume hot or warm beverages. A large percentage of the world consumes some form of hot beverage, either coffee, or tea, soup, etc. What the Nepton is trying to appeal to is these people's need for a device that allows them to enjoy their drinks for longer periods of time, without the hassle.

The way that team Nepton is selling this idea to their potential customers is through the angle of convenience and ease. The Nepton is very easy to use, and can seamlessly fits into anyone's lifestyle. While it is a premium product and does cost more than other methods for enjoying warm beverages, this doesn't deter people from purchasing higher quality devices. A perfect example is the Apple company's iphone line. Team Nepton is trying to provide quality hot beverage thermoses for those who truly enjoy their hot beverages.

D. Cost of Production

Based off our financial analysis, we have determined that the Nepton will cost approximately $50 for raw materials and $10 manufacturing. Although the prototyping bill of materials shows a significantly larger amount being spent on the prototype (roughly $150), this was due to the fact that we did not have the means to buy in bulk or develop our own custom parts and thus had to buy them from retail stores. The bill of materials below shows the theoretical cost of raw materials for the Nepton for manufacturing and the actual cost to build the Nepton prototype. The prices for raw materials are based on certain existing products similar to the products that the team needs.

Item	Cost	Price per pound	Weight (lbs)	link
Lithium battery	17.44			http://smile.amazon.com/Venom-3000mAh-6-Cell-Battery-Universal/dp/B000BJL03Q/ref=sr_1_2?ie=UTF8&qid=1423720601&sr=8-2&keywords=3000+mah+nimh+battery
Insulation	5.51			http://smile.amazon.com/M-D-Building-Products-4929-Fiberglass/dp/B00005202C/ref=sr_1_8?ie=UTF8&qid=1423720708&sr=8-8&keywords=heat+insulation
Electronics	~10			Radio Shack
Aluminum (Heat Sink)	0.14112	0.84	0.168	http://www.vincentmetals.com/Daily_Aluminum_Prices.html
Stainless Steel (Main Body)	3.9243	1.27	3.09	http://www.metalprices.com/metal/stainless-steel/stainless-steel-flat-rolled-coil-304
Stainless Steel (Inner Cup)	4.0767	1.27	3.21	http://www.metalprices.com/metal/stainless-steel/stainless-steel-flat-rolled-coil-304
Plastic Viritox (Lower Cap)	0.2288	1.6	0.143	http://standardceramic.com/Materials.html
Plastic Viritox (Upper Cap)	0.248	1.6	0.155	http://standardceramic.com/Materials.html
E-ink Display	12			http://www.pervasivedisplays.com/products/144#tab4
TOTAL	**$53.57**			

Figure 27: Bill of Materials for Nepton Raw Materials

Item	Quantity	Cost	Total Cost
Thermos 16-Ounce Drink Bottle, Black	1	23.1	23.1
Thermos 16-Ounce Drink Bottle, Black	1	23.71	23.71
Breadboard Jumper Wires (F-F)	1	6.99	6.99
40A SSR Solid State Relay	1	7.83	7.83
Embedded Artists 2.7 in. E-ink Display	1	54.01	54.01
Adafruit Waterproof Temperature Sensor	1	22.91	22.91
Immersion Heater	1	5.99	5.99
Painters Touch Black Spray Paint	1	3.87	3.87
J-B Weld High Heat Epoxy	1	5.67	5.67
TOTAL			**$148.41**

Figure 28: Bill of Materials for Nepton Prototype

E. Pricing Strategy

Given the cost shown above, the team has developed a pricing strategy. As such, we have decided to set the Nepton's price point toward the higher end at $100 as it is a premium product. With this pricing model, we are projected to have 40% profit per unit sale. To reduce manufacturing costs,we plan to outsource our manufacturing to foreign entities as well.

WORKS CITED

"Cancer." WHO | Cancer. World Health Organization, Feb. 2015. Web. 2 Feb. 2015. <http://www.who.int/mediacentre/factsheets/fs297/en/>.

Danova, Tony. "Just 3.3 Million Fitness Trackers Were Sold in the US in the past Year." Business Insider. Business Insider, Inc, 5 May 2014. Web. 9 June 2015.

"Healthy Beverage Guidelines." The Nutrition Source. Harvard T.H. Chan School of Public Health, n.d. Web. 2 Feb. 2015. <http://www.hsph.harvard.edu/nutritionsource/healthy-drinks-full-story/>.

Hitti, Miranda. "Hot Tea May Raise Esophageal Cancer Risk." WebMD. WebMD, 26 Mar. 2009. Web. 2 Feb. 2015. <http://www.webmd.com/cancer/news/20090326/hot-tea-may-raise-esophageal-cancer-risk>.

"Just 6.8M Smartwatches Sold in 2014 at an Average Price of $189." Just 6.8M Smartwatches Sold in 2014 at an Average Price of $189. Web. 9 June 2015.

Kikkerland Pixel Heart Morphing Mug. Amazon, May. Web. 1 Dec. 2014. <http://smile.amazon.com/Kikkerland-Pixel-Heart-Morphing-Mug/dp/B0073O127Q/ref=pd_sim_k_2?ie=UTF8&refRID=0KRJ3E3A7C8CNYZQ72SW>.
"SELF-HEATING MUG: Coffee, Tea, Soup, Baby's Milk Kept Warm While Traveling, WITHOUT Plugging in or Using Chemicals."Quirky. Web. 2 Mar. 2015. <https://www.quirky.com/invent/429060/action/>.

"Smartphone Users Worldwide Will Total 1.75 Billion in 2014 - EMarketer." Smartphone Users Worldwide Will Total 1.75 Billion in 2014 - EMarketer. Web. 9 June 2015.

Warner, Melanie, and Kim Severson. "Self-Heating Latte Cans Bring Out Lawyers." Business. The New York Times, 2 May 2006. Web. 1 Dec. 2014. <http://www.nytimes.com/2006/05/02/business/02puck.html?_r=0>.

Willacy, Hayley. "Oesophageal Cancer." Patient. Patient, 11 Nov. 2014. Web. 2 Feb. 2015. <http://www.patient.co.uk/doctor/oesophageal-cancer-pro>.

Zhao, Ping. "Cancer Trends in China." Japanese Journal of Oncology. Oxford Journals, 7 Dec. 2009. Web. 2 Feb. 2015. <http://jjco.oxfordjournals.org/content/40/4/281.full>.