University of Waterloo
Faculty of Engineering

BluPanda Project Summary: BluMug

Prepared by:
Arushi Mathur
Thomas Neter
Sarah Shabbir
Tanjot Panesar
Peter Shen
Andrew T. Wentzell
1A Systems Design Engineering
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Situation of Concern

Situation Impact Statement

Design a product for upper year undergraduate students to help reduce unhealthy levels of caffeine consumption through coffee, ultimately ensuring the health of students. This will be done by tracking the difference in caffeine consumption in milligrams over a specified time period by students before and after the regular usage of our product.

Situation of Concern Description

Caffeine affects everyone differently. The amount of caffeine consumed by the population varies from country to country. This is due to the fluctuating concentrations of caffeine levels within the coffee, the production of the coffee beans, manufacturing processes, and on the type of coffee prepared. The effects of caffeine commence after a time interval of fifteen to thirty minutes, and can retain in the body for up to eight hours, depending on a person's age, weight, and health. The half-life of caffeine once again varies on the health of a person, and the mean caffeine half–life is approximately 5.7 hours[12]. Caffeine can influence the central nervous system by interrupted sleep, causing changes in behaviour, and leading to anxiety. In the long run, caffeine has led to cardiovascular problems. The amount of caffeine safe to consume for a healthy adult revolves around 400mg per day, which is equivalent to two medium cups of coffee from a general coffee shop[11].

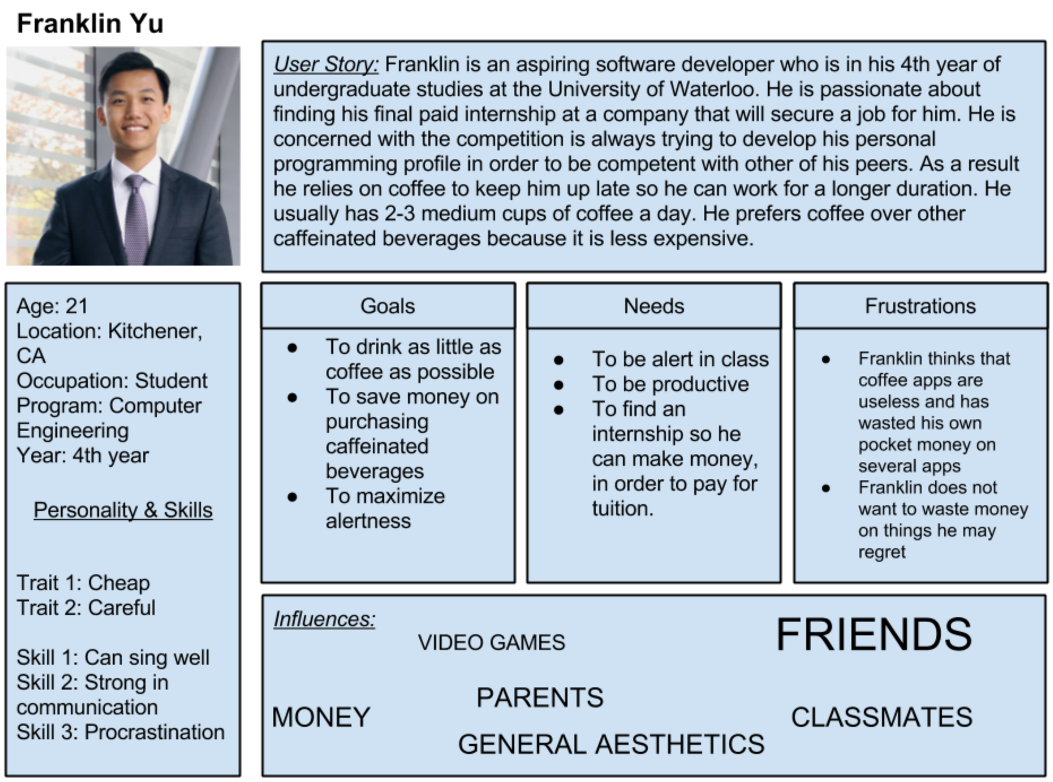
Requirements and Constraints of Problem

When defining a problem, it is important to define for whom it occurs. The safe amount of caffeine to be consumed by an average adult is 400mg[11]. A study conducted on undergraduate students showed that the 90th percentile and up, or 10%, of undergraduate students were consuming upwards of 490mg of caffeine, which is, by the EFSA standards, unsafe to drink. Therefore, the problem exists for the unfortunate 10% of undergraduate students, and ends only when the amount of unsafe consumption is reduced to negligible amounts.

Users

Primary Users

This design project is targeting upper year undergraduate students who drink coffee frequently, thus having an excessive/unhealthy amount of caffeine in their system. The BluMug coffee mug also targets users who are not yet addicted to coffee, but are on the path to becoming addicted and/or caffeine dependent.
An example primary persona is given:



An example of a Primary User

The locking mechanism was inspired by the primary users, as it is a method of motivating them to break their unhealthy habit. The locking mechanism is not a fool-proof method for controlling the consumption of caffeine and does not lock the coffee mug indefinitely, but the intention of the BluMug is to make its users aware of their caffeine intake. The locking mechanism serves as an effort to minimize the long-term health risks of excessive coffee drinking.

Another feature inspired by the primary users was the idea of an ergonomic shape and easily gripped material. The reason for doing so was that existing mugs and thermoses are not easy to hold, and so it became an inspiration to improve upon that in our final design.

Secondary Users

There are several other users that fall under the category of ‘Secondary Users’. One includes baristas at coffee retailers like Starbucks and Tim Hortons. Their direct contact and involvement with the mug is when primary users request their BluMug to be filled in-store. One feature inspired by them was the pop-off lid of the HFP. This allows baristas at coffee retailers to quickly fill the mug with minimized inconvenience, making it more efficient for those users. This speeds up the coffee-purchasing process significantly.

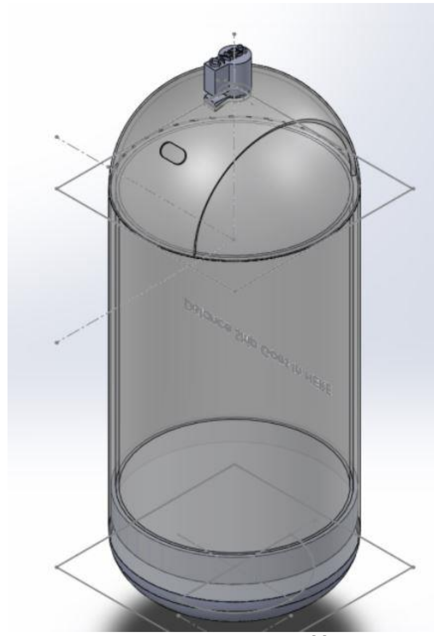
Another feature that was inspired by these secondary users was the calorie count feature. On the LCD screen, there are features within the code which display the calorie count of the product. The reason for this feature is that most coffee shops do not display the calories of the coffee after sugar, cream, and milk have been added. The new functionality allows coffee users to check their calorie counts as well as baristas, enabling further usage to be gained.

Tertiary Users

There are other stakeholders that have influenced our design based on their needs. These include places like recycling plants, in which the mug will ultimately end up. Our design for the final solution needs to utilize materials that were not harmful to the environment, or difficult to recycle. Other tertiary users include stores and retailers that will be carrying, selling, and promoting BluMug. This could be stores on campus with BluMug shelf displays, which encourages primary users to purchase our product.

Another instance of a tertiary user would be those involved in the manufacturing of the BluMug in which our goal would be to minimize production time and cost. This would be beneficial to both parties as the tertiary user would be able to expend less effort and time to assemble the product, resulting in a cheaper process. This inspiration can be seen in the final design as it is the overall design is simplified by the replacing the wiring with bluetooth and minimizing individual parts. As well, it would be ideal to craft the mug out of materials that maximize a compromise between quality and cost, creating a product we know the user will be satisfied with while also thinking economically.

Final Design Solution



The final design solution includes an additional Bluetooth module located in a compartment on the lid of the mug. The additional Bluetooth will be placed to communicate with the pre-existing Bluetooth module in the compartment located beneath the mug. The reason for this design option is to limit the unsafe wires and that are exposed in our current high-fidelity prototype. Besides this, the Bluetooth communication would allow for the lid to be completely removable from the mug.

Something important to notice is that the BluMug's final dimensions are changed in this solution due to an improved electronic compartment regarding physical space. The Arduino is replaced with are pcb board which contains only the necessary components soldered. This will reduce the space allocated for the electronic components that make the locking mechanism function.

Furthermore, the most important change from our final prototype to our final design solution is the method or means to measure how much coffee is in the mug. For feasibility and algorithm testing purposes, an ultrasonic sensor was used to measure distance. These distance values were then used to calculate volume, using the pre-determined dimensions of our mug. In our final design solution, we are projecting to utilize a capacitive sensor by equipping a level bar that can communicate with the sensor. This detection fluid level that measures displacement of liquid will be placed vertically. Another addition to our final design solution is a more optimized algorithm that can take the change in angles through an accelerometer and gyroscope MEMS sensor. The six dimensions of freedom will allow us to track any change in rotation around the x,y,z or change in acceleration in the x,y,z. Using this data we will be able to turn off the capacitance sensor from checking a change of volume. The reason for this whole addition is to optimize the BluMug's battery life.

Final Prototype

The BluMug final prototype is an accurate representation of the projected mechanical and electrical functionality of the final design, rather than an accurate representation of the ergonomic and the heat retaining abilities of the mug.

The final prototype is 25 cm in height , 8.9 cm in diameter, and is created to replicate the maximum coffee that an upper-year undergraduate student should consume. With the equivalent volume to two medium coffees, the final prototype is able to measure the volume of coffee that

User Testing

The final BluMug prototype was given to users to evaluate its ergonomics, and to display its functionality. In general, users noticed three things: the product is not ergonomic to hold, it is heavy, and it is not aesthetically pleasing. After realizing this about our HFP, the HFP was examined to further understand its faults. To begin, due to the material used and the functionality-oriented HFP, the mug was not equipped with grippy material. This created an undesirable experience when attempting to hold the container as it was not shaped ergonomically and it was too heavy. Continuing the examination, it was found that due to the increased size of the HFP, the weight of the electronic components, and the larger electronic components used for testing functionality, the product became heavier than anticipated. Finally, the lack of effort in hiding wires, electronic components, and decoration lead to a general consensus that the HFP was an unattractive product.

Performance Testing

<u>Seal</u>

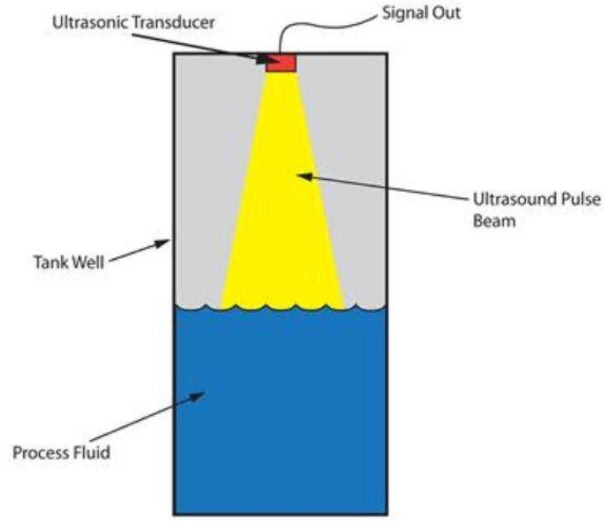
For measuring the tightness of the seal, tape was attached to the PVC cap, and on the other end of the rope, weights were attached. For different weights, the prototype was lifted, and when the prototype’s lid came undone, the current weight was recorded, and we tried different weight increments for the same prototype to ascertain the accuracy of the measurement. In this test as well, all electronics were removed, as a sudden movement in the prototype could damage them. In the case where the rope was too long to be lifted by hand, the tests were moved to an empty stairwell. Priority was given to those using the stairwell.

<u>Durability</u>

A drop test was used to test the durability of the mug when it was dropped. This test evaluated the material from which the cup was made, and its durability when it came into contact with another surface. We tested for the maximum height from which the cup could be dropped, without causing noticeable damage to the product. In order to conduct this test, all the electronic components were removed from the cup before it was dropped. In the case where the test exceeded 7 metres, the test was stopped, as the performance of this metric was deemed more than necessary for the uses of this product.

Locking Mechanism / Electrical components

Because the locking mechanism was connected to the electronic components, it was tested alongside the electrical components. First, it was tested whether the ultrasonic sensor would react properly to the distance it calculated, through the locking mechanism. Second, the locking mechanism was adjusted so it would turn at the right angle and lock for the correct time. If mistakes were found during any of the tests, the respective aspect of the electrical components or coding was adjusted accordingly.

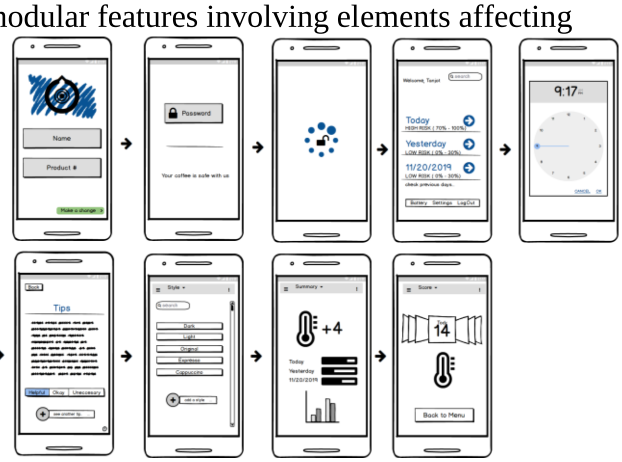


Future Work

In terms of improving the design of the coffee mug itself, the next steps will target the ergonomic component of the design. When looking at the ability to hold the mug, the focus will be on the shape of the mug, and designing it so that the user is required to apply the least amount of force to hold the mug upright. Now, the body of the high-fidelity prototype is a simple cylinder that is able to incorporate the hardware components necessary for the mug to function. The next steps will be to shape the body of the mug to improve ease of handling, while being able to secure the hardware components in a more effective way. Another factor we are considering is the material of the mug. The high-fidelity prototype was constructed of polyvinyl chloride(PVC) because of the availability of the material and lack of other resources. In the future, this product should be constructed of material that is highly robust, much like the PVC, and heat resistant and impact resistant. To prevent the user from burning their hands when using the product, the material should prevent heat from not only escaping easily from the container, but also from transferring through the cup and burning the user. A grip can also be made to prevent burns and promote ease of use.

Over the past few months, the focus of this design project had turned towards ensuring that the locking mechanism worked, as that was the sole purpose of the coffee mug. The next steps regarding this problem look at the ability to wash the mug without having to removing the hardware components. Currently, an ultrasonic sensor is being used to evaluate the distance of the liquid from the top of the mug. While this was a fine solution due to lack of resources, if the design idea were to be pursued, a liquid level sensor would instead be used to evaluate the level of the liquid, as this product is waterproof, and accomplishes the task that we are trying to achieve while also simplifying the wiring of our current system.

Currently, the BluMug can calculate the caffeine levels of the user, and to lock the cup whenever the user's body contains over the healthy amount of 400mg. Within the future of this design, the next steps are to build a customized app that will allow the user to manage their caffeine consumption more thoroughly. This app will allow the user to select the type of coffee they are drinking, and will display to the user their different caffeine concentrations. Additionally, the app will contain modular features involving elements affecting caffeine depletion in the user, such as being able to select the user's activity type, and will implement this input into the BluMug's calculations. This app will also help a user become more aware of the negative health effects that caffeine can cause, and will provide a user with motivation to reduce their caffeine consumption levels. To help a user reduce their own intake levels, the app will also provide healthy lifestyle tips, plans, and guides that will create an even more personalized user experience.



Conclusion

By the end of this term, we were able to produce a design that satisfied our initial goal of helping undergraduate students reduce their caffeine intake. We targeted the 10% of upper year undergraduate students who consumed over 400mg of caffeine on a regular basis, and worked towards helping these users become more aware of the amount of coffee they were drinking by creating a solution that stopped a user from drinking though there are aspects which could have been done better. The initial brainstorming period was spent focusing on a problem that eventually proved to be inapplicable to the demographic of upper-year undergraduates, which consequently had a slight negative impact on the time we were able to spend designing. Once our problem was narrowed to caffeine we were able to focus on a few prototypes, finally deciding to create a coffee container which was able to track the user’s caffeine intake and help reduce consumption.

Individual Reflection Component

Team Member #1 – Sarah Shabbir

The most challenging aspect of the design project was honestly finding a problem to solve. Not that problems were hard to find, but finding a problem that didn't already have an effective solution for available was difficult. I know that you are not supposed to be thinking of designing solutions when brainstorming for problems, but I believe it is still necessary to keep potential solutions in mind. This is because of reasons such as constraints on resources (there are certain bounds involving the complexity of the design solution), limited knowledge in certain fields (again, it restricts us, the designers, from creating something too excessive or elaborate/complex), and constraints on time (less than 4 months from start to finish).

If we go back to one of the very first stages of the design project, brainstorming, we had trouble when selecting a problem to design a solution for. We first thought to approach the problem of lack of sleep in upper year students, however it was difficult to come up with a solution as it couldn't extend beyond our combined skillset. Another problem idea we had was the lack healthy eating and exercise but, there were already multiple solutions on the market to this problem. Finally, we tried tackling the issue of lack of hydration in students. From that we thought to develop a smart water bottle, but many already existed that far surpassed anything we could develop with the time we had. Since the goal for this design project was to develop a unique solution, we asked ourselves how we can improve upon already existing designs. We needed a solution that was different, creative, and able to be crafted with the skills, resources and time we had. So instead of water, we chose coffee. Due to this brainstorming process, I learned the most important thing, which was having a strong base, and clearly being able to define the problem you are solving makes the rest of the design process a lot easier by erasing any ambiguities.

Team Member #2 - Andrew Terry Wentzell

The most challenging aspect of this design project for myself was trying to amend a lack of focus for the project. There were many aspects of the BluMug which required attention, and there was a lack of experience with delegation, for example, the app, and the Bluetooth connection. As a result, a trend of last-minute design decisions developed, and while most of the functionality of the product remained, a lot of the ergonomic goals were not met. The result is a fully functional product with Bluetooth connectivity and possible app connectivity, but little to no aesthetic appeal.

The most important thing I learned was the importance of research before implementation. As mentioned in the paragraph prior, many decisions were made last minute. The reason that these last-minute decisions were made was a combination of lack of research and lack of forethought, however, the lack of research definitely made it harder to develop our final design. Additionally, because of this lack of forethought, there was more criticism of our final design. A perfect example of this is the decision to always measure the liquids volume, rather than to measure it only when necessary. This decision lead to abundant wastes in battery power, and a final product that tests to minimum functionality in the final product.

Team Member #3 – Tanjot Panesar

The most challenging aspect of the design project was finding the balance between moving fast to produce candid ideas and allocating more time to certain aspects of the design process. I believe our team lacked the ability to reference back to what was once created and continue to develop it further by changing it. For example, once our high-fidelity prototype was created out of pvc tubing, our group was set on the first cutting and carving on the pvc pipes. Although we did create three low fidelity prototypes, a medium fidelity prototype, and a high fidelity, I think our final high fidelity could have been significantly improved if our group created multiple medium fidelity prototypes after several evaluations phases. Hence, time limitations and constraints had an impact on our design, either for the better or for the worse, but overall was challenging to compensate for.

The most important thing I learned about was how a design is assessed or deemed as "good" or "bad". The question of whether a design is good or bad is not finite to a scale, which means to a user a design may be good, which may differ from the next user. The difference between design and engineering design is that there are finite metrics involved, which requires multiple trials of the product in different testing environments. I learned that because of these metrics, there is evidence behind every aspect of a product or service and a reason for every function to be existing in a product.

Team Member #4 – Arushi Mathur

I believe that one of the most difficult or challenging aspects of this design project was finding a problem. In the early stages of this project, finding a problem in health and wellness was quite difficult because of the lack of awareness of what design and problem analysis really was. When trying to come up with a problem, we had an amazing brainstorming session in the beginning of the year revolving around loneliness and self-identity. While this remains an amazing topic, we were struggling to develop a solution that could solve loneliness or lack of self-awareness that did not already exist. After conducting some research, we came to realize that the problem of unawareness was more prominent in the first-year population instead of upper year undergraduate students. After conducting some research, talking to upper years, and surveying, we decided to change our focus, and found that over consumption of coffee was a real issue that upper year undergraduates were facing, and decided to pursue that problem instead.

One of the most important things I learned over the last three months was to thoroughly understand a problem before pursuing it. Assumptions can be the downfall of a design solution. By making assumptions, we decrease the accuracy of our statements, and until extensive research is conducted on the problem space, the design process is immediately halted. After thoroughly evaluating our problem space by talking to students, evaluating journals, statistics, and more, we were able to finally move ahead with our solution with a better idea of who we were targeting, and what their customer requirements were. Because our research was initially lacking, we ended up targeting only a small population of undergraduate students who drank an excessive amount of coffee daily.

Team Member #5 – Peter Shen

The most challenging aspect of the project was making decisions for our product as a group. For example, this entailed deciding which problem to solve, which design solution should we proceed with etc. It was challenging to resolve conflicting opinions about any decision that had to be made during the process. For example, when choosing which problem space to target, there were mixed opinions. Some wanted to target sleep deprivation, some wanted coffee overconsumption, and some wanted wrist writing pains. It was challenging to reach a consensus with so many different ideas and go forward as a group.

The most important thing I learned was the iterative design process. This is kind of humorous since it is analogous to saying the most important thing I learned was the entire course. However, learning and applying the iterative design process has taught me how to develop solutions/systems/products in an organized and effective manner. Organized being that there is a set development process that you must follow. For example, you need to do your research first, identify your users, design prototypes, test your prototypes etc. This organization allows for the creation of a functioning product in a quick and efficient manner. Moreover, it is effective in the way that you are designing a viable solution. In the design process, the problem space needed to be thoroughly researched and the effectiveness of your product to that problem was also thoroughly tested.

Team Member #6 – Thomas Neter

The most challenging aspect of the design was definitely identifying a viable, researched problem with upper year undergraduates. Our initial brainstorming consisted of many rich ideas involving identity and purpose, which we were all extremely passionate about, but following further research and surveying proved to be insufficient for our problem space. At this point most of our effort had been focused on these ideas as we were overly confident of our biased, uninvestigated thinking, so having to scrap a considerable amount of work was definitely difficult. Eventually, once we decided to focus on caffeine consumption as our problem, we faced another obstacle yet again; deciding on a realistic solution. Although the implementation of our solution was challenging, it required less effort as it was more interesting, whereas brainstorming felt more challenging as there were countless constraints on what we could create.

The most important thing I learned was how important the engineering design process is. Despite mentioning how monotonous some of its aspects were, the overall process is pivotal in planning out a thorough and efficient design. Having focused on some aspects more than others, it was evident which parts were done less diligently when we were met with a crossroads or a dead end with our design. The major issue we faced in the process was poor time management in the iterations of our designs. Had we created more thorough prototypes the jump to the final HFP would have been less drastic and could have produced a more desirable physical product.

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