Hydro Harvest: Self-Watering Planter

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Figure 1: Team photos from the proposal and final presentation

Executive Summary

In this report, we detail the process we went through to develop our product, Hydro Harvest, from comprehensive market research and customer interviews to researching intellectual property and eventually designing various iterations of prototypes based on customer feedback and troubleshooting. From our market research and customer interviews, we identified the need for an automated plant watering device for people who live busy lives and may not have the time to sufficiently water their plants regularly in order to maintain plant health. The main objective of our product was to create a self-watering device that automatically dispenses a certain amount of water using a timer to water a houseplant. The product reduces the need to constantly water plants manually, thereby decreasing the number of plant deaths by houseplant owners. Our customer feedback provided us with the main needs of ease of use, a high water capacity, and customizability, which are all aspects we tried to incorporate as we created various prototypes. Our final design incorporates a timer to regulate timed-release of water by opening the faucet and dispensing a pre-programmed amount of water from the water storage container above the plant. This allows for users to determine how much water they want to release and how often, which tackles the obstacle of different watering requirements for different plants. While we continuously designed new prototypes in accordance with customer requirements and our various ideas, we realized

that many ideas were infeasible due to our limiting factors which included a lack of resources and money. However, in the future, we hope to upscale our product, outsource materials, and receive adequate funding in order to create a more complex system that will truly represent all customer needs.

Background

Houseplants are commonly utilized for decorating home and office spaces, largely for aesthetic purposes, but the benefits extend beyond aesthetics. In fact, houseplants have been proven to improve mental and physiological health by reducing stress and suppressing sympathetic nervous system activity[3], which stimulates comfortable and soothing emotions. 66% of American households own at least one houseplant, with the US market for the houseplant industry representing a $1.7 billion dollar industry[2]. However, the average household kills seven plants, often due to neglect and insufficient watering habits. There is a demonstrated need for an automated houseplant watering device to mitigate the unnecessary plant deaths for busy individuals who desire to obtain the positive benefits from owning houseplants but may not have the time to maintain plant health.

Business Opportunity

Product Value

The problem we sought to solve was the need to automate the process of watering indoor plants in order to maintain plant health. It is evident that different types of houseplants possess different watering schedules; however, it is easy for busy or lazy house planter owners to forget to water their plants. The solution to the issue of plants being under/overwatered is an automated self-watering system that allows for timed-release of programmed amounts of water. This allows for individuals who own plants to easily program a watering schedule for their plants easily and efficiently in order to allow for optimal plant watering patterns. Additionally, this can be helpful for plant nursery owners to water every single plant regardless of their particular watering requirements, thus easing the stress of the owner.

Market Analysis

There is a big market opportunity for self watering devices because 66% of American households own at least one house plant, indicating that these individuals are possible customers[2]. In fact, the US generates over a billion dollars in the houseplant industry a year, demonstrating the vitality of the market. Between 2022-2029, the indoor plant industry is expected to increase to 26.23 billion dollars globally[2], which will allow for Hydro Harvest's market to expand subsequently.

Figure 2: indoor plant market predicted trajectory[2]

Competitive Landscape

The competition for a self watering device is plentiful. The competitive landscape consists of many other products on Amazon that are all similar in terms of how water is delivered to the plant. Many competitors, such as the WOUSIWER Self Water Planter[1], directly connect the water source being connected directly to the plant itself, whether through the use of a cotton rope connected to the water source to allow absorption of water via capillary action or a gravity driven water dripper that slowly dripped water to the soil. Many use a gravity driven device that slowly dispenses water to the soil of a plant, such as the Travelwant Self Watering planter[4]. There are some products that use special materials that are placed between the soil of the plant and the water, where the material absorbs the water and

passes through to the plant's soil. These methods are less precise and thus are more difficult to use in order to regulate the amount of water being released to the plant, which has the potential to lead to overwatering or underwatering.

Customer Needs

From our customer interviews, we concluded that the top three customer needs from a self-watering planter are high water capacity, ease of use, and customizability. We interviewed individuals who are self proclaimed "plant parents," who already actively own plants, and individuals who are interested in owning plants but have been hesitant to for reasons ranging from laziness and unsuccessful previous attempts. It is necessary to have a high water capacity so the plant can be watered for days without refilling the water storage. Additionally, the product must be easy enough for busy individuals to figure out and use so that it is easier than watering by hand. Lastly, it is important to have customizability with regards to watering plants of different sizes, require different amounts of water, and possess different watering schedules. We considered various business and market aspects in terms of partners, resources, and customer relationships and compiled them in a business model canvas.

Business Model Canvas

Our main customers will be plant parents and nursery owners who can utilize our product and sell it to their customers. We hope to partner with big retailers such as Amazon, Walmart, Target, Home Depot, Orchard Supply Hardware, etc. in order to expand our reach. We hope to create a website and a store for our product eventually in order to allow for customer feedback, which we will then take into account for when we design new prototypes. Furthermore, we will advertise our product on social media channels and through various plant fairs. Additionally, we will need to outsource certain materials for our pots, faucets, and water dispensing hoses, along with recruit more members to our team who have knowledge of different aspects of engineering and manufacturing.

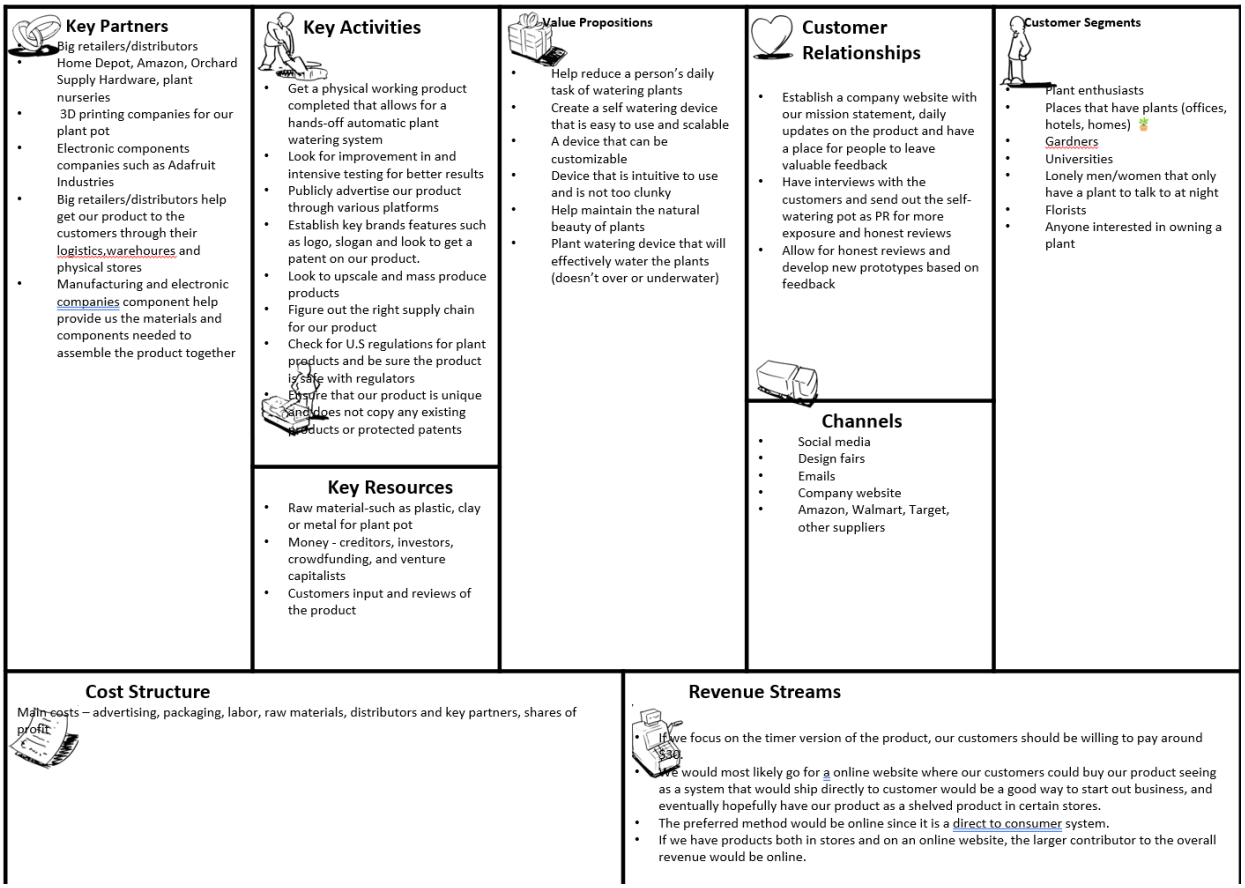

Figure 3: Business Model Canvas

Concept selection:

We initially wanted to create a product that allowed for customizability, timed and specific water release, high water capacity, affordability, practicality, and was aesthetically pleasing. There were multiple concepts that we considered while working on this project, amounting to around sixteen different concepts that we narrowed down to the top four using a Pugh Matrix.

		Gravity-fed		Adjustable water-flow		Portable and customizable design		Automatic water level and controller activated	
Selection Criteria	**Weight**	**Rating**	**Score**	**Rating**	**Score**	**Rating**	**Score**	**Rating**	**Score**
Affordability*	20%	3	0.60	3	0.60	4	0.80	2	0.40
Ease of use*	20%	4	0.80	4	0.80	4	0.80	2	0.40

Aesthetics	15%	2	0.30	3	0.45	5	0.75	2	0.30
Customizability	5%	2	0.10	1	0.05	5	0.25	1	0.05
Power source	5%	4	0.20	3	0.15	1	0.05	4	0.20
Practicality*	20%	3	0.60	3	0.60	2	0.40	1	0.20
Water capacity	10%	4	0.40	4	0.40	1	0.10	4	0.40
Sustainability	5%	3	0.15	3	0.15	1	0.05	3	0.15
Net Score	-	3.15		3.2		3.2		2.0	
Rank	-	3		**1**		**1**		5	

Table 4: Pugh Matrix detailing our concept selection

Prototypes

From our discussions, we concluded that we wanted to create a device that had controlled water flow, allowed for multiple cycles of watering before refilling with water, and incorporated a timer. We initially considered incorporating a solar power aspect along with more complex water dispensing mechanisms, but soon realized that these ideas would require circuitry knowledge beyond our scope. The prototypes we chose ranged from, a hydraulic press system that has a pump like system that pumps water into the plant from a series of pipes, a fountain like system that would have a water dispenser in the middle of the planter that would draw water from the water storage from the bottom of the planter and would flow the water out from the top of the water dispenser flowing down as if it were a fountain, a gravity-fed drip system that can be programmed to dispense water, and a capillary action system that stores water on top and uses rope to dispense water. However, many of these designs were infeasible due to 3D printing constraints or functional limitations, such as a lack of water storage or pressure for water to flow. For our final design, we attempted to incorporate different aspects of some of the previous prototypes, including the timer idea along with a system that resembled gravity-fed system more but could be programmable.

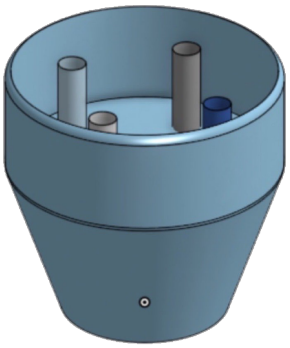

Figure 5: hydraulic press system

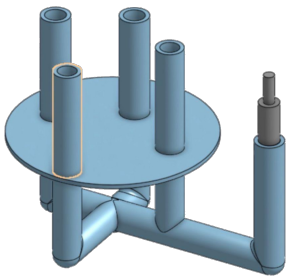

Figure 6: fountain-like system

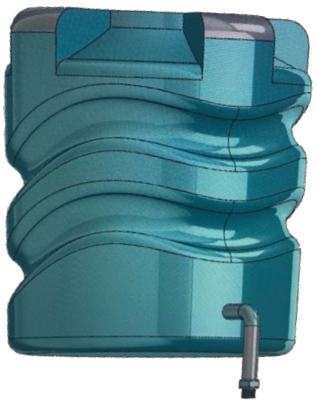

Figure 7: gravity-fed system

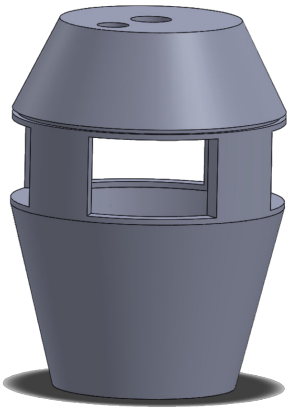

Figure 8: capillary action system

Design Specifications

For our final design, we based our design around the average pot size, which is a 6 in tall and 6 in in diameter pot. For upscaling of the actual product, we would allow for a wider range of pot sizes depending on user preference. The water storage is approximately 4.5 in in diameter and 6 in in height that can hold around 100 mL of water. With 100 mL of water, depending on how much water the customer sets the timer device to release, we can promise that the water should last for at least a week without refill for smaller plants. In future iterations of the prototype, we hope to increase the water storage size to accommodate a larger water capacity to allow for less continous refilling.

The timer is optimal for allowing the user to input how much water they want to dispense at a time and how often it should dispense in order to best fit each individual plant's needs. Unfortunately, many of the design specifications were limited due to issues with the amount of time it would take to 3D print and the cost of materials.

Selected Concept

For our selected concept, we decided to go with a timing mechanism that is connected to the water source, which currently is designed as a water storage container that can be filled with water. The time can be set, once the timer reaches the set time, the faucet valve opens and releases water into the plant. The components are easily assembled together and allow pieces to be easily changed if they break. The water pot, water storage, and valve can be fabricated through a 3D printer, which allows the customers to customize their desired specification and modify the dimensions to fit their needs. The timer itself allows you to set the intervals between watering cycles from every few minutes or every few days. The timer also allows you to set how much water and how long the water valve is turned on ranging from a few seconds to minutes depending on the needs of the plant. The water goes through a tube in the timer, which in future iterations will also connect to a hose that allows for more controlled water release.

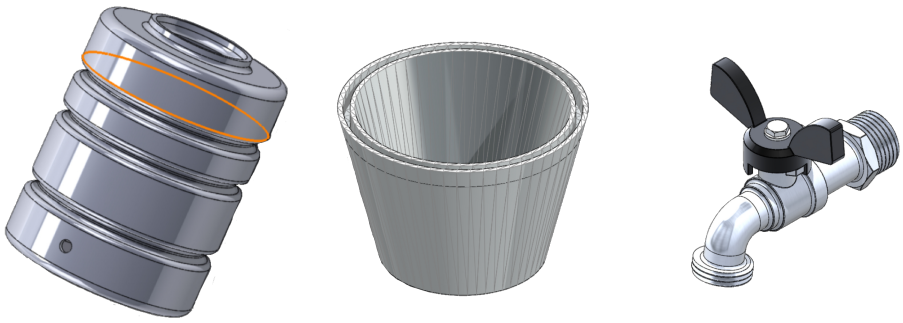

Figure 9: CAD designs of multiple parts of our design

Figure 10: Product assembled, ideally a hose would connect to the timer for amore powerful stream

Our product satisfies the need for an automated device that allows for both controlled water release and a programmable schedule. Depending on user preferences, the water storage can be larger and will sit on a platform that can be attached to a wall, while the pot will be positioned directly below it.

Team Reflections

We enjoyed using what we have learned at UC Berkeley from previous three dimensional modeling courses to learning about the product development process from Mechanical Engineering 110 to create a physical product. We used many important aspects of product development such as concept sketches, customer interviews, collaboration, patent research, business opportunity, prototyping, weighted specifications, and a lot more. The market analysis and business opportunity research allowed us to consider all aspects of needs and requirements that we wanted our product to fulfill. Customer interviews and feedback granted us the ability to incorporate ideas that were truly desired. For the technical side of product development, we utilized SolidWorks to design computer aided three dimensional prototypes of our concepts. Additionally, we used manufacturing processes such as 3D printing to fabricate our designs.

From the beginning, all team members had very complex and intricate ideas for the product. However, we soon realized that some of our ideas would require skills that we did not possess, such as

circuitry and electronics skills. This prevented us from pursuing more complicate designs that would allow for even better control of customizability and timed water release. In retrospect, having another team member that had intimate knowledge of these skills would have been extremely beneficial, especially in terms of deciding a power source and automating the device.

Furthermore, we began our product fabrication somewhat late. After we attempted to fabricate the initial prototype, we realized that some parts of our design were not feasible to be printed within the size and time constraints of the Jacobs Makerspace. This prevented us from printing larger prototypes that required more material and were more complicated, thus forcing us to modify our design to be more simple. Moreover, we realized that our major limiting factors were time, resources, and money. We did not want to have to pay too much out of pocket to continuously print prototypes that did not work. However, it was also difficult to modify the prototypes without testing it out physically.

In the future, we will work on testing physical prototypes earlier. We would also try to consult people with different skills who can aid with more than just the CAD prototypes in order to best leverage all of our skills. We learned that it is important to expect roadblocks throughout the product development process and that it is necessary to be flexible and adjust quickly to obstacles such as prototypes failing.

Future steps would include designing a more complex water dispensing system and considering the electrical component to the product. Additionally, we would design different sized pots, water storage systems, and possibly add a more intricate water dispensing system with a hose.

References

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[3] Mayers, Katie. "Houseplant Statistics in 2023 (Incl.. Covid & Millennials)." *Garden Pals*, 28 Apr. 2023, gardenpals.com/houseplant-statistics/

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