BOTAMIST

Report 2

Indoor Herb Garden

Spring 2021

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Contents

Cover Page	0
Contents	1
Mission Statement	2
Customer Needs	2
Customer Feedback	3
Component Selection, Detailed Design, and Testing	5
Final Design	6
Sustainability Life-Cycle Analysis	9
Patent Analysis	10
Market Position	11
Business Plan and Financials	13
Next Steps	16
Retrospective	16
Appendix	17

Mission Statement

To empower your inner gardener.

Our mission statement evolved over time from the longer and more specific "To develop a stylish, low-maintenance, self-lighting and -watering herb-growing system for homes, that will empower your inner gardener." The original statement was more aligned to the mission of the project to create the alpha version of our product. But as our team considered more the mission of the company and the needs of our customers we decided to shorten it and guide us as our North Star. Our product is built to remove the barriers to entry of gardening for those who may be passively or actively looking for alternatives to store bought herbs and other leafy greens.

Customer Needs

"...I buy herb bushels from the grocery store and always end up throwing some out because I never use it all..."

The first two sprints focused on finding customer needs that we see an opportunity to address. From there we have analyzed these to create specific features that speak to our "Trader Joe's Chefs". Our goal being to provide a solution to customers who use herbs in cooking, are interested in gardening, and are attracted to trendy sustainability. Our solution is an indoor gardening product and the below chart depicts how we translate the specific needs they have that have to be met in order for them to adopt our product. Our customers typically live in apartments where space is at a premium and they like the idea of being mobile should they need to pounce on a new opportunity. These customers care about the environment as they often skew toward the Millennial and Gen-Z generations and being eco friendly is as much a real environmental concern as it is, considered by some, a character trait. And to most the highest rated piece of feedback we received is the aesthetic need to exemplify their sustainably minded persona while seamlessly integrating into their decor.

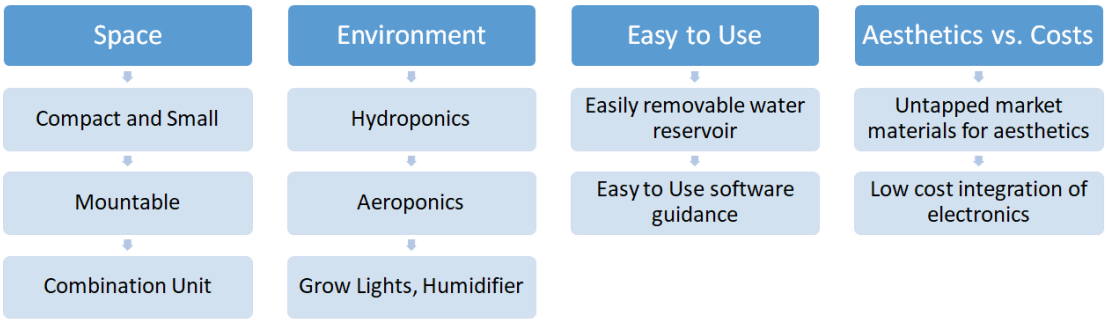


Figure 1. Customer needs matrix.

Our designs to this point have enabled us to pivot as we learned more about what is most valued. Two design families, the "cabinet" & "nuclear core", have carried us to this point and can be seen below. The spider web shows how the key customer needs are met by each of the designs. The nuclear core truly captures the aesthetic appeal that is so important to winning over the customers, especially from our main competitor the Aerogarden. The decision from here was to move forward with refining the nuclear core product.

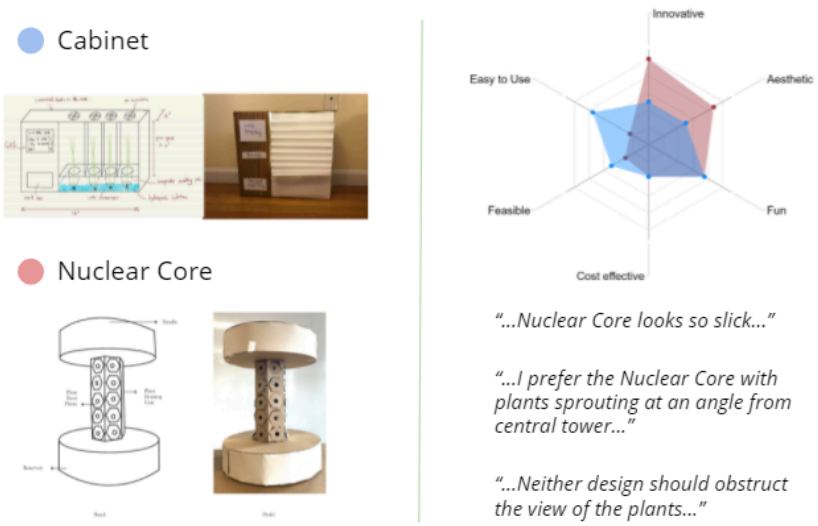


Figure 2. First prototype product families and radar chart performance scores.

Customer Feedback

"...I really like the idea...I've been looking into countertop growers, but didn't like having to buy a whole tray of basil or a single plant..."

This section focuses on the customer feedback we received in our working model iterations and rendering for an alpha prototype. The early part of this sprint we quickly created a working model that could be demonstrated to customers to get initial impressions. Below customers provide their feedback on different aspects that really influenced where the next design changes needed to come from. Clearly, the design was on the right track for aesthetics, but the size was straddled between compact and efficient and large with a high number of plants. Some of the features we added were not as interesting as we'd thought and other's needed to be improved.

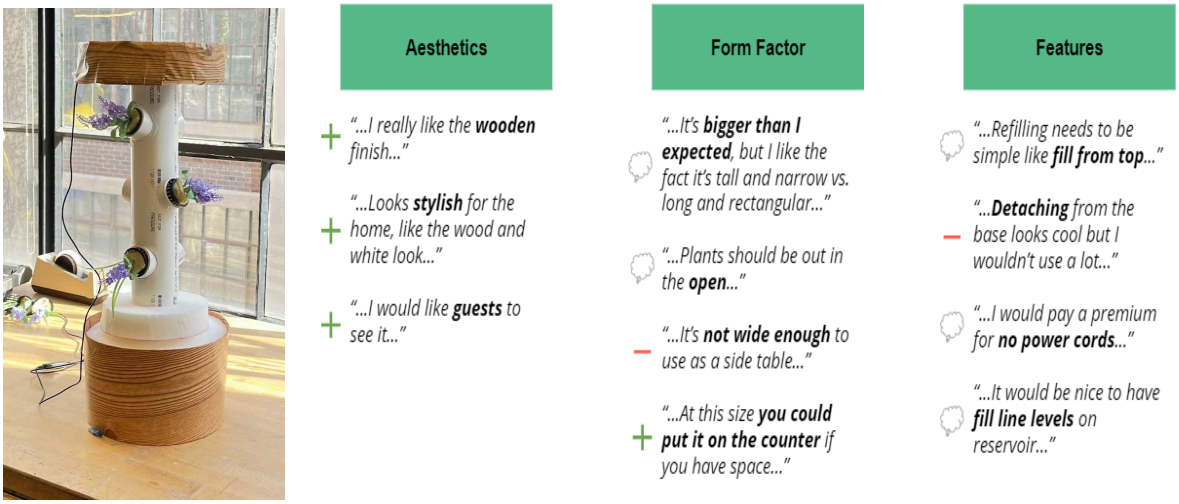


Figure 3. Customer feedback on working prototype.

The next step was taking our existing working model and refining it based on the most recent wave of feedback. The prototype is right sized to fit under a kitchen cabinet or be easily moved elsewhere in the house. The advanced lighting and misting systems are both functional and are easy for the customer to figure out. The pump is also quieter. Overall they enjoyed interacting with the product and found it at home in theirs. But we were not done yet.



Figure 4. Customer feedback on refined prototype.

While testing the working prototype the design team was hard at work creating 10 iterations of what could be our alpha prototype's final shape. All relied on the same technology, but because aesthetics are so important we knew this was a critical step. A survey was sent out to 33 participants who were randomly shown 5 products to compare along with that of our main competitors as benchmarks. Below is a heat map showing the highest performing designs across the different questions we asked. The green areas indicate high performance while the red is low. We want customers to buy this item because they think it can become an important part of their decor and culinary life. They should find it very appealing to look at and want to show it off to friends. All of these factors lead us to select #10 on the far right.

"...The color of the wood really blends in well with herbs..."

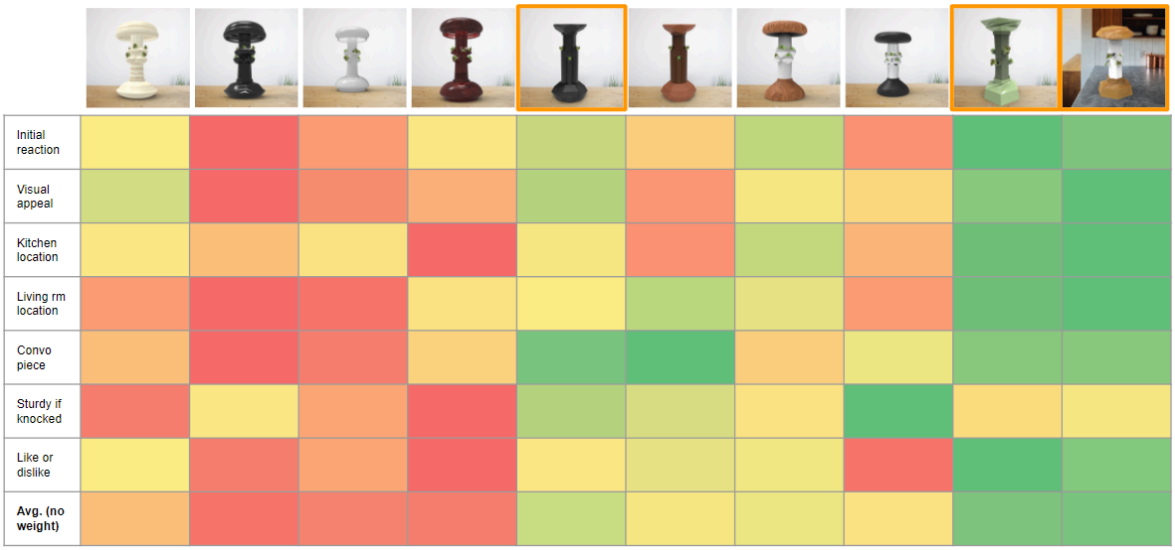


Figure 5. Heat map of product design variations based on customer ratings of key performance metrics.

Component Selection, Detailed Design, and Testing

Misting: Our first misting subsystem was a proof-of-concept of low pressure aeroponics. This version was composed of a plastic tubing connected to a submersible pump. The plastic tubing was held upright through the use of narrow PVC pipe. There were two key issues with this first version. First, it offered one opening for flow into the plant growing chamber (at the top), and this opening was not well-positioned to cover plant roots. Second, the submersible pump was too underpowered (3W) to drive the desired high flow rate. The second version of the misting unit addresses these challenges. First, we used rigid sprinkler tubing that could attach directly to the pump to remove the need for both plastic tubing and PVC. Second, we cut holes in a spiral pattern up the length of the sprinkler tubing and screwed low cost 360-degree sprayer nozzles into the holes. Now, spray can emanate along the height of the pipe within the plant growing chamber. Finally, we purchased a higher power pump (25W) that could supply a much higher flow rate. We are confident the second iteration will keep the plant roots adequately misted during operation of our device.





Figure 6. Misting prototypes 1 and 2

Lighting: Lighting is a critical subsystem that has to be selected carefully to achieve high performance growth. Aeroponic systems like ours can benefit from longer artificial light cycles of up to 16 hours of "daylight" for optimal growth. For our system, a full spectrum mix is best at a color temperature near 5000k using LED's outfitted in a ring shape around the top of the structure facing. LED's offer a cooler burn rate and flexibility in specifying exactly spectrum and brightness. Additionally wattage is important as we consider the typical power needed by the square footage of plant growth to be 25 W/sqft. Lastly distance from the plants is critical so plants are located no closer than 4 inches and no farther than 8 inches to ensure growth. All of these considerations were taken into account for the final prototype design. The off the shelf ring light captures much of the "looks like" and "works like" requirements; however, it is not as precisely engineered as what a full production model would be.

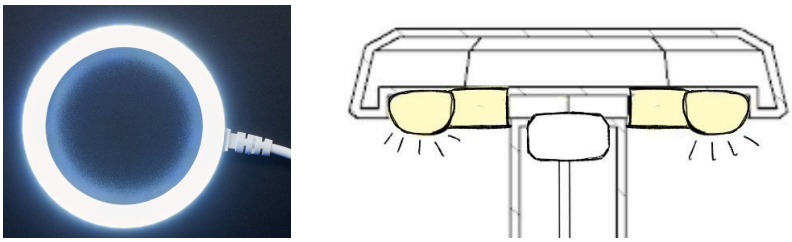


Figure 7. Working prototype of the lighting solution and detailed position in CAD.

Structure: Because aesthetics are so important, the physical structure of the product is one of the most critical components to get right and a considerable amount of effort was spent iterating here. From customer interviews on the mock up, the team learned the dimensions were too large for most kitchen and living room spaces, an enclosure wasn't desired, and was overcrowded with planting options. With that, the team went back to the drawing board and began making adjustments to reduce the size and bring the number of planting locations to six. The next round of prototyping reduced the height from 30 inches to 18. The second refined prototype was well received, but required changes to the shape as described in the customer feedback section. In the next section, the final structure and artistic finish is shown.

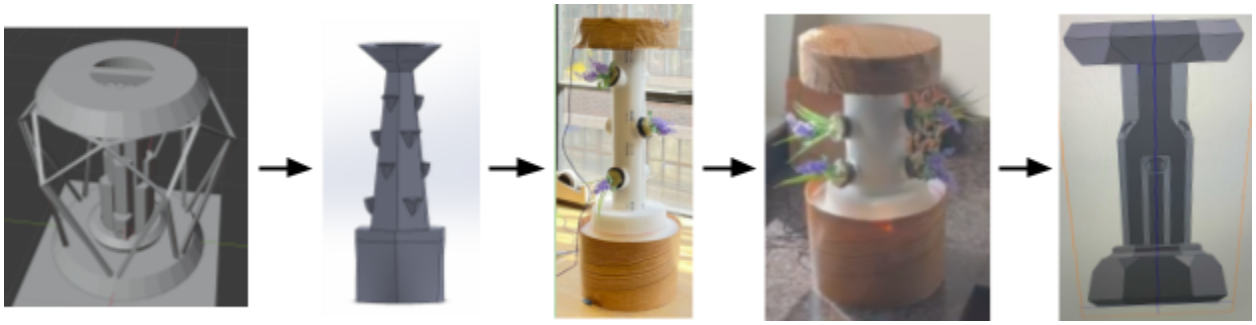


Figure 8. Different iterations of the structural design in CAD and prototypes leading.

Final Design

This final design is based on all the technical considerations and customer feedback we have analyzed up to this point. The latest working model received feedback that led us to reduce the overall size and move further toward a geometric design pattern, while reinforcing the technology decisions we had made. Specifically, the pre-installed halo lighting subsystem and aeroponic pump subsystem that moves nutrients and water directly to the plant roots for optimal growth. The aesthetics have continued to be a top priority and the results of the customer design survey moved us to choose a wood pattern, hexagonal shape, and tower structure for the plants to grow from.

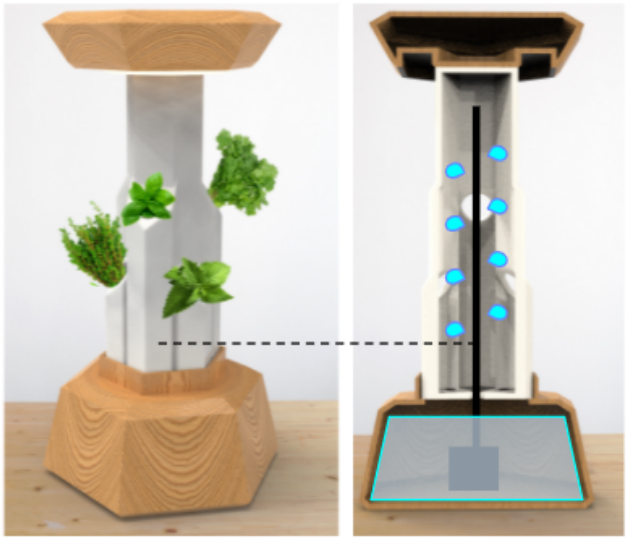


Figure 9. Alpha prototype rendering.

The alpha design is able to achieve the customer specifications that align to the metrics below which we feel are the most critical to be successful.

Customer Need	Metric	Units	Specs
Space	Overall Height	in	<19
	Footprint	in	<11
	Weight (wet)	lb	<11
Environment	Recyclable materials	binary	yes
	Can grow organic plants	binary	yes
	End of life buy back program	binary	yes
	High efficiency growing	binary	yes
Easy to Use	Single plug	binary	yes
	Number of plants	count	6
	Water supply	days	>6
	User systems	count	<3
Aesthetics	Unique structure	binary	yes
	Wood grain pattern	binary	yes
	Form fits space requirements	binary	yes

Table 1. Customer needs based specifications.

Additionally, the alpha product design allowed us to create the streamlined user experience as seen below. The customer has very few required interactions with the product to start using it immediately. The drop in pod system, pre-measured food amounts, and simplified electronics make this a very compelling design to reduce the barriers to entry for latent gardeners.

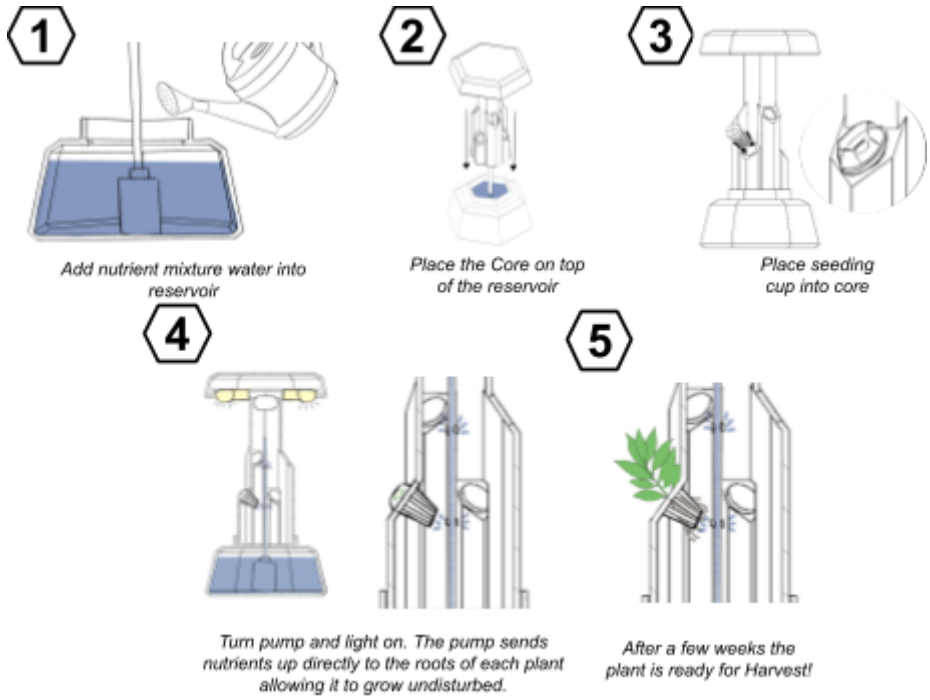


Figure 10. User guide for getting started with their first plants

Lastly, the final alpha design allowed us to develop a bill of materials to ensure we had a strong grasp on the costs associated with manufacturing the product. While the alpha is not exactly what would be in a production model the components closely represent and work like one. The BOM below represents the current estimates for two important aspects: the planter and the seed kits. The planter is the main device used to grow the plants and has a current cost of $52 to manufacture. The 6 pod seed kit, which contains everything needed to grow the plants (except water) costs $5.89. These are numbers used in our financial analysis to determine the value of the business to evaluate profitability.

Item for Botamist Planter	Per unit cost
Pump	$15
Pipe cap	$0.25
Pipe	$0.50
Nozzles (6 per unit)	$0.90
Plastic Shell items (3 per unit)	$7.70
Light	$16
Nutrient solution	$1.81
Packaging	$1.83
Seeds	$0.13
Seed Holder material	$1.71
Seed basket	$1.32
electronics interation	$4.80
Total Cost	*$52.00*

Table 2. BOM for planter with material costs.

Item for Botamist re-grow pack	Per unit cost
Nutrient solution	$1.81
Packaging	$0.92
Seeds	$0.13
Seed holding material	$1.71
Seed basket	$1.32
Total Cost	*$5.89*

Table 3. BOM for re-grow pack with material costs.

Sustainability Life-Cycle Analysis

We used the Sustainable Minds System BOM software to understand our product's impact on the environment, across different lifecycle stages including material selection, transportation, end of life, and use. We assumed a useful life of 3 years and functional unit of 1 year. Analysis showed that in our reference model, power consumption (use) for the misting and lighting subsystems dominated the carbon footprint. The cadence of the aeroponic misting system and lighting for optimal plant growth is largely empirical, leading us to assume a 1:15 minutes on/off cadence for the pump and a 14:10 hour on/off cadence for the LED lights. At power ratings of 25W and 20W respectively and assuming continuous growing throughout the year, this implies a yearly footprint of 63 CO2 eq. Kg, roughly equivalent to <1% of a homes' average energy use per year. In modelling usage, we felt we should also account for the fact that customers would likely not be using the product throughout the year, pausing in between growing cycles or holidays, and so assumed an average utilisation of 70%.

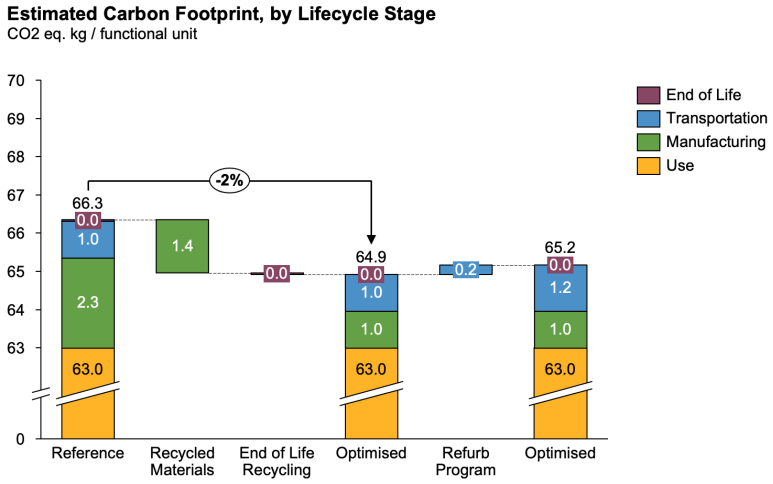


Figure 11. Carbon footprint analysis over lifecycle of unit.

For manufacturing, we shifted from the material used in our reference prototype, ABS, to recycled HDPE bottles, which has a much lower carbon footprint, saving over 50%. At the quantities we are aiming to sell, injection molding is still the preferred option over additive manufacturing, which would also require an additional proofing process.

Finally, although the end of life cost of landfill is orders of magnitude lower than other stages, as part of our branding, all products should be able to be recycled and avoid landfill. We include an additional case of a return and refurb program (in the same vein as Patagonia's Worn Wear) which adds slightly to the overall carbon footprint through transportation, but enables a new revenue stream and also brand affinity with customers. In this analysis we did not model the material impact of the pump and lighting components (too complex) or the seeds and growing medium (negligible impact).

Patent Analysis

We identified multiple US utility and design patents related to aeroponic growing towers, of which those from known competitors Aerospring and Tower Garden, are shown below:

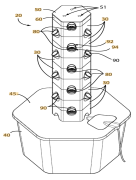
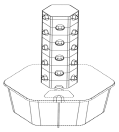
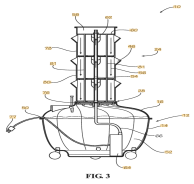
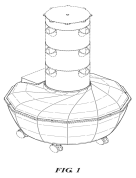
Number	Assignee	Name	Granted-Expiry	Selected image
US10772270B2	Aerospring Gardens Pte Ltd	Aeroponic column	2020-37	
USD809965S1	Aerospring Gardens Pte Ltd	Aeroponic column	2018-33	
US10888055B2	Tower Garden LLC	Hydroponic plant cultivating apparatus	2021-36	
USD792807S1	Tower Garden LLC	Hydroponic plant cultivating apparatus	2017-32	

Table 4. Patent evaluation.

Following consultation with a patent attorney and based on the patent search, our product appears patentable. It was recommended that we should focus on filing a provisional utility patent based on the aeroponic watering system, given the technology formed the core of the design.

We believe this invention is patentable based on the following factors:

- **Novelty:** Although the central vertical position of the pump and pipe subsystem is seen in prior art, the use of nozzles acting radially to compress nutrient solution into mist and directly spray on to plant roots is novel
- **Utility:** The product is useful as outlined in the customer needs section; it allows customers to grow herbs at home and is also designed to be more aesthetically pleasing in the home
- **Non-obviousness:** Existing designs are generally taller and carry more plants. Water is pumped to the top of the structure and left to naturally fall down as a spray. It is not bvious to

i) minituarise the form factor of a tower garden to more of a kitchen countertop size and ii) change the misting system for more efficient and direct coverage.

Market Position

Our product aims to be the first in the market that integrates the proven efficacy and efficiency of aeroponics at a miniaturized scale for countertop usage. In addition to considering size, designing the product to be aesthetically pleasing to the "Trader Joe's chef" customer segment provides another advantage over the more boxy products currently in the market. The quad chart illustrates the size and portability of current market competitors and the green star indicates where our product fits in this landscape.

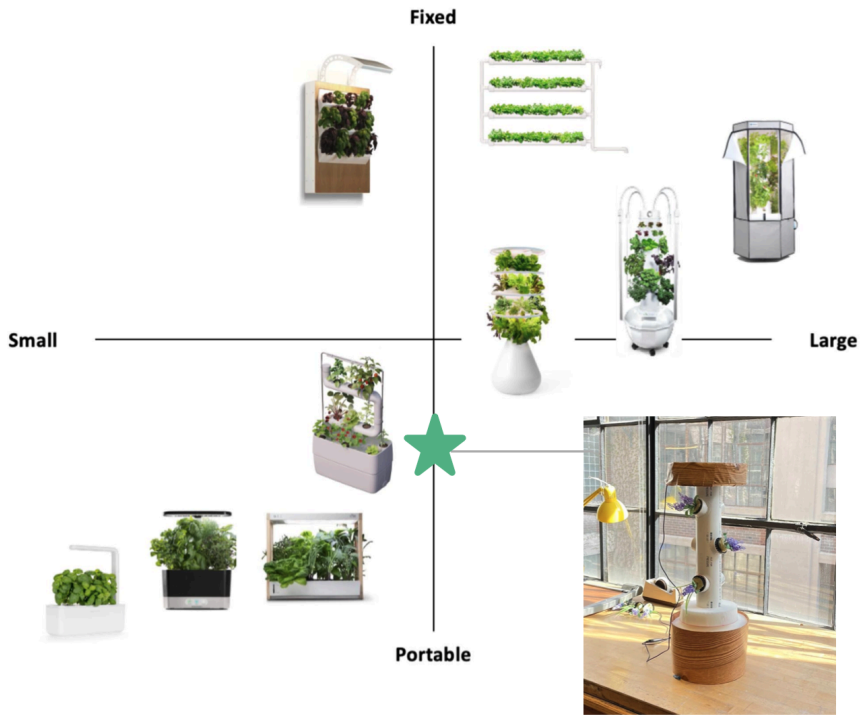


Figure 12. Competitive landscape.

As we surveyed our potential customers about their needs, preferences, and lifestyles, we included some questions about what our product should cost or what they would pay. Based on customer responses illustrated in the figure below, it is clear that they see our product as costing somewhere more than the $99 AeroGarden and less than the $350 Lettuce Grow. This is a validation of our goal to enter the market at a premium to the AeroGarden and reinforces the initial research we conducted around the market opportunity.

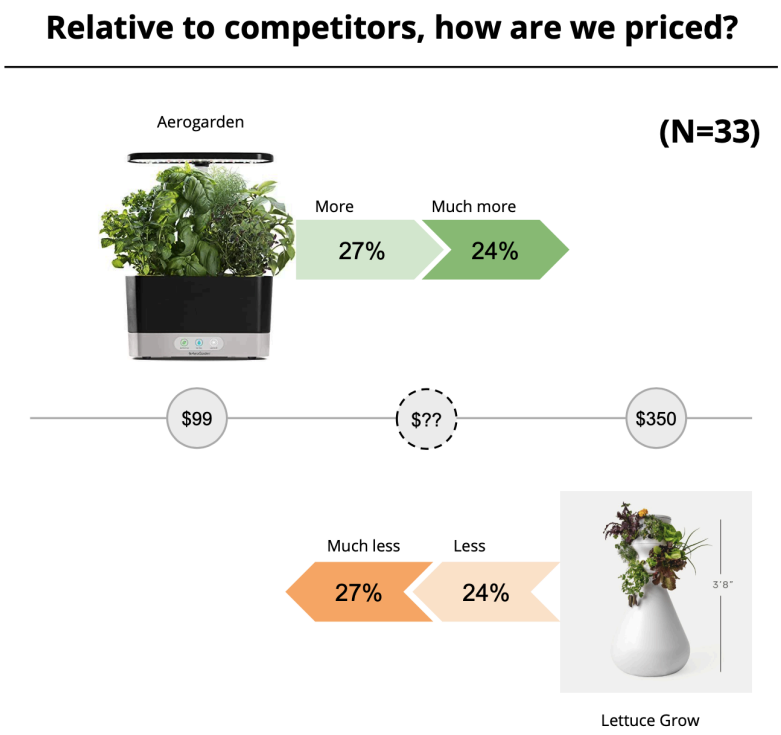


Figure 13. Pricing analysis through customer surveying.

After our initial sprints, we had gaps in our understanding of where in the home or apartment the customer envisioned placing this product. Returning to the identified customer need that the product is easy to use and listening to their feedback about time constraints, we pivoted from an initial idea of a piece that could act as a decorative end table to a countertop product that let them access their herbs right at the point of use in the kitchen. The size of the initial working model, though it validated the overall concept and component interactions, did not provide the right dimensions for customers to keep it in their kitchens. So we redesigned our product to limit the height to fit on a kitchen countertop and customers responded positively to these changes. From a market perspective, we also felt this change significantly increased the number of customers to whom our product would appeal because the smaller footprint increases the likelihood that a customer can fit the product in their home.

Although our product can conceptually enable the customer to grow any number of plants, the product was designed to accommodate the most popular herbs of cilantro, basil, mint, parsley, rosemary, lavender, thyme, sage, and oregano.

Business Plan and Financials

We will pursue product commercialization with a start-up company. Below is a high-level breakdown of the go-to-market strategy:

Year 0: First product to market at test scale (<5k units) on Amazon retail
Year 1: Scale up product manufacturing and marketing push (10k units)
Year 2: Launch website and develop additional B2C retail partnerships
Year 3-5: Scale-up production (>100k units/yr) and achieve >10% market share target

We estimate the cost of goods sold (COGS) of both modules offered (Table 5): the Planter Device and Re-grow Pack. The Planter Device includes the Botamist planter as well as the materials necessary to do a complete grow cycle. The Re-Grow Pack includes the materials to do an additional growth cycle. Please see Section 5 of this report for a complete bill of materials for both modules. In addition to materials cost, the COGS provided also includes a contribution due to labor. For the device, we estimate that this contribution is 10% of the total COGS. For the Re-Grow Pack, we assume that the labor contribution is negligible.

We will sell our product to Amazon to be sold on its online marketplace. We assume Amazon will request a 50% margin on this product. We select $160 as our price to consumers on the marketplace, as we believe our product aesthetic and enhanced growing capabilities warrant a premium price relative to the Aerogarden, which sells for $100-120, depending on model. To achieve a $160/device price to consumers on the Amazon marketplace, our price to amazon must be $80/device (Table 5). By subtracting COGS from the price to retailer we get a gross margin of $23.50/device or 27%. A similar set of calculations can be done for the Re-Grow Pack, where we set a $16/unit price to consumers that is benchmarked to similar type grow kits. Fixed costs we consider include salaries for mid-level managers in manufacturing/assembly, facilities costs, and salaries for 2-4 members of a business development team.

Module Name	Type	COGS	Price to Retailer	Price to Consumer	Gross Margin
Planter Device (includes starter kit)	Device	$58.66	$80	$160	$23.50 (*27%*)
Re-Grow Pack	Re-up materials	$5.90	$8.00	$16	$2.10 (*26%*)

Table 5. Pricing and cost summary.

We make several key assumptions in our financial modeling (Table 6). In particular, we make three assumptions about user habits regarding attrition (ID# 5-6) and average yearly grow cycles (ID# 7).

Attrition refers to the continued use of the device beyond a particular milestone, and determines the amount of Re-Grow Packs will be purchased after initial Planter Device purchase. We break up attrition into two components: 1) within-year, and 2) next-year attrition. Within-year attrition is the percentage of Planter Device purchasers that do not go on to use the device after using the starter kit. Next-year attrition is the percentage of users that do not continue using the device into the next year. As a base case, we estimate 50% for both within-year and next-year attrition. So, the probability of a purchaser continuing to use our device after 12 months is 25%, which seems reasonable based on our stakeholder interviews. We assume other grow packs are not used with our device.

Yearly grow cycles is the number of herb batches (of six) that are grown by a participating user in a year. One grow cycle is assumed to be five weeks. We assume yearly grow cycles to be five, which means the user is growing for approximately half the year (25 weeks).

ID#	Variable	Type	Assumption
1	Discount Rate	Financial	10%
2	Tax Rate	Financial	35%
3	Market Size (Year 0)	Financial	$105M
4	Market Growth Rate	Financial	8%/year
5	Attrition (Within Year)	User Habit	50%
6	Attrition (Next Year)	User Habit	50%
7	Average Yearly Grow Cycles	User Habit	5 Cycles

Table 6. Financial analysis assumptions.

We create a financial model for a start-up based on the Botamist product (Figure 14, left). This model encompasses the present until Year 5 of the start-up. Dynamics in years beyond Year 5 are approximated using a perpetuity with underlying growth. We conservatively estimate a 4% growth rate after Year 5, which is half that of the current market growth rate of 8%. Our model predicts an attractive NPV of $40.2M for the start-up company. The NPV of our initial Botamist Planting Device is

estimated to be $3.7M by summing discounted cash flows for Year 0 to Year 5. In addition, our model indicates the start-up would be profitable by Year 2.

Unlike other products with consumables, such as the Keurig product line, consumables are not the leading source of revenue for our product (Figure 14, right). In fact, we predict just ~25% of total revenue would come from Re-Grow Packs. Since we additionally estimate gross margin to be approximately the same between the device and consumable (~25%, Table 5), we conclude that most of our profits will be made from the device and not the Re-Grow Packs. So, it will be important to continue to innovate to produce new and improved Planter Devices for sale. However, Re-Grow Packs are still an important revenue stream, and are also necessary for continued customer experience with our product.

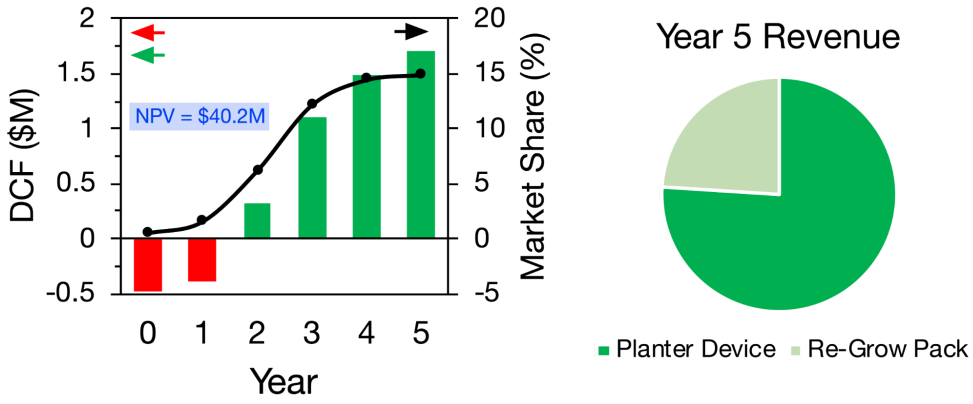


Figure 14.Revenue and DCF summary.

We explore the sensitivity of start-up NPV to 17 variables (Figure 15, left). Our sensitivity analysis indicates that our model is most sensitive to discount rate, market share achieved in Year 5, and retailer gross margin (Figure 15, right).

ID #	Variable	Base	Best	Worst
1	Device Material Cost ($)	$52.79	$47.51	$58.07
2	Re-up Unit Material Cost ($)	$5.89	$5.30	$6.48
3	Market Growth (%/y)	8%	11%	5%
4	Device Initial Retail Price ($)	$160	$176.00	$144.00
5	Re-up unit Initial Retail Price ($)	$16	$17.60	$14.40
6	Device Retail Price Growth (%/y)	3%	6%	0%
7	Re-up Unit Price Growth (%/y)	3%	6%	0%
8	Within Year Attrition	50%	35%	65%
9	Beyond Year Attrition	50%	35%	65%
10	Device Labor Cost (% of COGS)	10%	7%	15%
11	Retailer Gross Margin (%)	50%	45%	55%
12	Tax Rate (%)	35%	30%	40%
13	Market Share at Year 5	15%	20%	10%
14	Initial Marketing Spend	$100,000	$50,000	$150,000
15	Marketing Spend Growth	12%	6%	18%
16	Average Grow Cycles/Year	5	7	3
17	Discount Rate	10%	8%	12%
18	Recycle Rate	0%	10%	0%

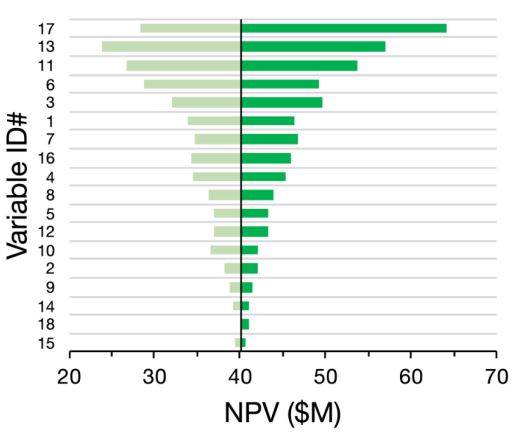


Figure 15. NPV Tornado.

Next Steps

Sprint 5 is dedicated to developing the final reports, presentation, and Alpha prototype. None of this would be possible without the continued action plans, standups, and meeting cadences. The team has taken the necessary steps to outline the precise actions on a day by day plan and saw 3 work streams: Report Planning, Final Model, and Presentation. The Gantt chart below is updated to reflect the high level activities for the sprint excluding this report. Each task has an owner who is overseeing the specific actions within each.

The most important tasks as we wrap up is finalizing customer impressions, recording their feedback, creating content for the presentation, and documenting "what we would do next". We know this final sprint will not result in a perfect production model, but based on the final round of testing and feedback we'd like to document key areas of development to consider if there was a next iteration. This will be produced for consideration in our final presentation.

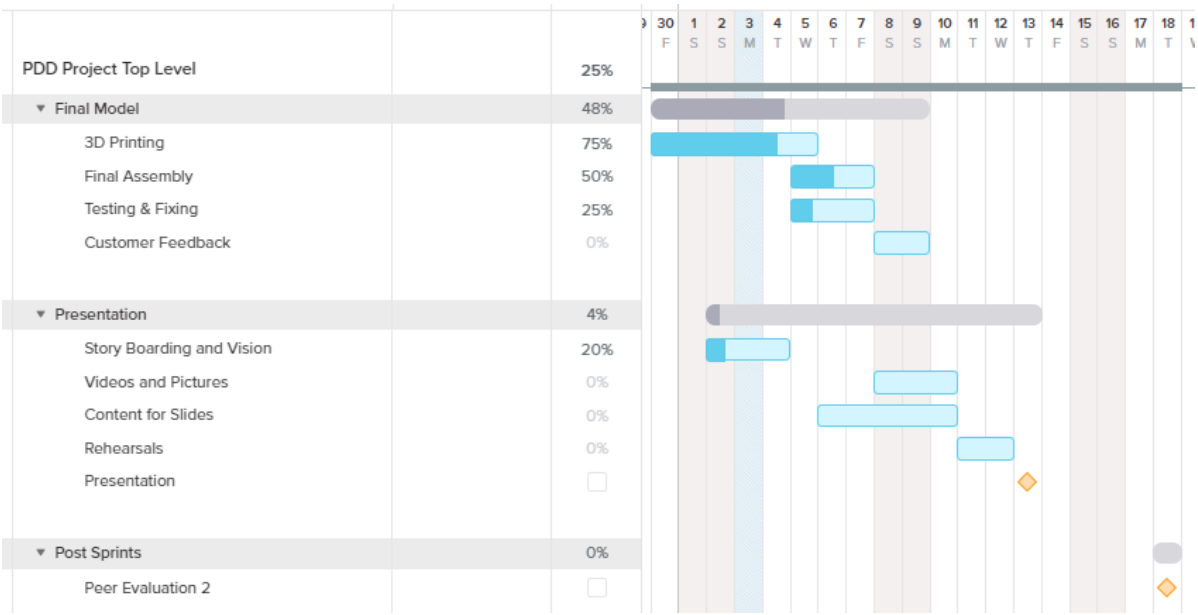


Figure 16.Gantt chart for sprint 5 as of 4/29.

Retrospective

Our team has built off the first two sprints by developing formal structure and role responsibilities. The initial sprints were a great way for us to try different activities and determine here our strengths and where we needed to focus.The figure below depicts how the team divided into sub teams for tackling the specific challenges of our subsystem. Each member also had to take on individual functional responsibilities which greatly helped us understand who was the subject matter expert or owner of a deliverable. Our working rhythm hit a strong cadence by kicking off joint planning sessions with ad hoc sub team meetings to accomplish needed tasks with daily check ins. Several working sessions with the prototypes occurred in the IDC and were essential to completing the

physical aspects of this project. Lastly, we continued to meet at the end of sprints for a "retrium" activity where we cover what went well and what we need to do differently.

Appendix

Appendix 1. Selected screenshots from last retrium exercise

