Development of Self Watering Planter

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MASTER THESIS

Development of Self Watering Planter

For IKEA of Sweden

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Abstract

Both during and after the pandemic, the trend of biophilic design has reached maximum acceleration. One of the consequences being an increasing interest in gardening and plant care in general. Though not everybody might have so called 'green fingers', everyone should have the opportunity to try, and a product that facilitates horticulture is the self watering planter. IKEA of Sweden is looking into the development of a self watering planter specifically for outdoor use. The aim of this project is to develop a new product following the Democratic Design principles, incorporating circularity goals and overall creating a concept that fits the IKEA profile.

Combining Ulrich and Eppingers concept development process introduced in *Product Design and Development* and the IKEA design principles mentioned before, research was conducted to find the customer needs as well as overall needs for the plants and product requirements in general. Internal benchmarking was performed by combing through IKEA catalogues from 1998 up until the printing concept was abandoned in 2021. External benchmarking was performed by searching for existing solutions on the market involving different kinds of self watering.

Iteratively with the research, a concept generation in the form of sketching and 3D-modelling took place. Comparing with the needs, a first concept selection dismissed some irrelevant concepts. The next step was using the Democratic Design principles for concept scoring which lead to a final concept being chosen that could then be further developed regarding aspects such as simplicity, transportability and manufacturing. This resulted in a planter solution using the wicking method to water the plants consisting of four main parts and an optional plug. The solution can be both an insert and a planter by itself, it is easy to use, assemble and clean and can be stacked during transportation. Finally, the thesis project has resulted in a concept with much potential and IKEA is therefore suggested to continue the development of the self watering planter.

Keywords: self watering, planter, product development, design, IKEA

Sammanfattning

Både under och efter pandemin så har trenden med biofilisk design fått sig ett rejält uppsving. En utav konsekvenserna är ett ökat intresse för trädgårdsarbete och växtvård generellt. Fastän alla kanske inte besitter så kallade 'gröna fingrar', så borde alla få en chans till att försöka, en produkt som underlättar odling är den självbevattnande krukan. IKEA of Sweden undersöker utvecklingen av en självbevattnande kruka specifikt för utomhusbruk. Målet för detta projekt är att utveckla en ny produkt som följer Democratic Design-principerna, integrera cirkularitetsmålen och överlag skapa ett koncept som passar IKEA profilen.

Genom att kombinera Ulrich och Eppingers konceptuvecklingsprocess som introducerades i *Product Design and Development* med IKEAs designprinciper som nämndes tidigare, gjordes efterforskningar för att hitta kundernas behov såväl behoven för växterna samt allmänna produktkrav. Inre benchmarking utfördes genom att genomsöka samtliga IKEA-kataloger från 1998 och fram tills dess att det tryckta konceptet övergavs 2021. Yttre benchmarking utfördes genom att söka efter existerande lösningar på marknaden med olika typer av självbevattning.

Iterativt med efterforskningen skedde en generering av koncept i form av skissande och 3D-modellerande. Genom att jämföra med behoven gjordes ett första konceptval för att avfärda irrelevanta koncept. Nästa steg var att använda Democratic Design-principerna för att utföra en poängsättning av koncepten som i sin tur ledde till valet av slutkonceptet som sedan kunde vidareutvecklas efter aspekter som enkelhet, transportabilitet och tillverkling. Detta resulterade i en planteringslösning som använder bottenuppsugningsmetoden (wicking) och består av fyra huvuddelar och en valfri propp. Lösningen kan både vara en innerkruka eller en fristående planteringslåda. Den är enkel att använda, montera och rengöra samt kan staplas under transport. Slutligen har detta examensarbete resulterat i ett koncept med god potential och IKEA har föreslagits fortsätta utvecklingen av den självbevattnande planteringslådan.

Nyckelord: självbevattning, planteringslåda, produktutveckling, design, IKEA

Contents

1 Introduction

IKEA is a global company founded in Älmhult, Sweden in the 1940's by Ingvar Kamprad with a focus on home furnishing. Though it took some years for IKEA to become the franchise that is known today, in the 1970's, Kamprad wrote "The Testament of a Furniture Dealer", summarizing several of the values and the mindset that is still applied in the company today. It was in this testament that the IKEA vision was first concertized: to create a better everyday life for the many people. [27]

As of today, the company is divided in different business areas, BA's. The BA's are in turn divided into so called HFB's, or Home Furnishing Businesses. Some examples of the different BA's, and perhaps the ones customers are more familiar with are Bedroom, Kitchen, Children's and Decorations. There are several more BA's and one of them is BA DOW, Business Area Dining Outdoor Workspace. This BA is responsible for developing all dining furniture such as chairs and tables, all furniture and commodities used outside, all workspace related furnishing such as desks and office chairs, and finally also secondary storage, for instance shelf solutions perfectly suited for the garage or similar. This project is in collaboration with BA DOW, more specifically the Outdoor team, Home Furnishing Business 17, HFB17.

1.1 Background

Product development teams are responsible for not only developing new products and product families, but also for renewing and improving those already existing. This can mean drastic changes, for instance altering dimensions for improved packaging, or smaller changes such as a colour update. Many new project have been taken on by the different teams at the BA's for this time period. One of the projects HFB17 is working on is the product family which the concept for this master thesis will be a part of.

1.2 Problem description

The Outdoor team, HFB17, is working on a new product family where one of the products is an outdoor planter. The planter should be part of or itself double as a sectioning unit, in the likes of a fence or trellis structure. As of today, IKEA does not offer any outdoor approved self watering products. Therefore, the main task for this project is to develop the self watering mechanism for the outdoor planter pot, more precisely two different proposals for how this problem could be solved. These shall be presented as 3D models, drawings and with proof of functionality such as simulations and simple tests of physical prototypes. To increase the chances of the product being able to sell, there will be much thought behind how it could be packaged effectively, therefore one of the final deliverables for the project is a simple packaging proposal. If relevant, there shall also be some assembly proposal. Being part of a product family, the project will be somewhat dependent of the rest of the development team in order to achieve harmonic resemblance.

1.3 Delimitations

Reasonable limits had to be set for this project early on as the timeline and project plan for the thesis work was unfortunately quite misaligned from that of the PD team. For clarification, the mentioned product family is only one of many concurrent projects taken on by the team in a shifted as well as prolonged time period.

The project therefore has focused on the self watering insert of the planter, and not the solution for the outer part of the pot or the sectioning. It was also set that the project would end at a fairly early stage of the development process, and follow the deliverables as mentioned in section 1.2. If the product proposal is accepted, the development team will take on the necessary following steps needed to release the product. When it comes to prototyping, it was decided that the goal was not to produce a sample in the intended material nor dimensions, as the time constraints would not allow for this. Simple glued prototypes in the right size and at best a 3D-print was set as the limit.

1.4 Confidentiality

A different kind of limitation for the project is how not everything will be presented when it is finished due to confidentiality. This could mean some results or decision making processes not being available to the public.

1.5 Available resources

IKEA has provided the project with a laptop prepared and licensed with SolidWorks as well as unlimited access to many of the Inter IKEA online tools, for example the Sustainability Tool. Physical resources include office spaces, ideation spaces and a workshop for prototyping. Though the latter is equipped with all kinds of machinery which requires one to go through certain training, the simpler tasks on non-threatening equipment could be utilized whenever. Finally, the most important resource for the project has been the insight and help from the professionals. Invitations to meetings and presentations just to observe the way of working has given great insight and inspiration of how to create e product that fits the IKEA profile.

2 Method

Though the goal is to develop a product, the sub-steps can be arranged or grouped differently depending on what method is being used. The following chapter will describe some of the development activities performed for this project as well as the design principles applied. Both general and IKEA specific guidelines will be presented.

2.1 Product development and design

The term product development refers to the several steps and activities involved when making a product. It is a journey following the product from early ideas, continuing until it can be released on the market and of course beyond that point. [38]

2.1.1 Concept development - Ulrich and Eppinger

In *Product Design and Development*, Ulrich and Eppinger (2016) define the product development process as the six steps shown in figure 1 below.

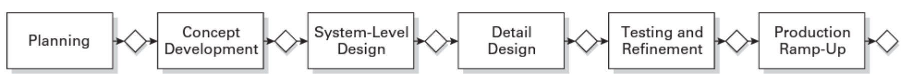

Figure 1: *Product development process according to Ulrich and Eppinger. [31]*

Much of the general planning had been done by IKEA for the project regarding the entire product family, but an individual timeplan for the thesis project can be seen in Appendix A. The second step, concept development, can in turn be divided further into activities as can be seen in figure 2. Concept development is an iterative process with overlapping activities that is the main focus of the book, and is approximately what this project has been based on as well.

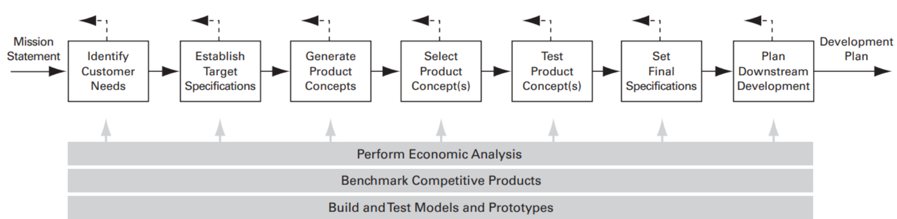

Figure 2: *Activities for concept development according to Ulrich and Eppinger. [31]*

2.1.2 Design for X

The term Design for X, or Design for Excellence (DfX), is used for a number of design guidelines when developing products. Some examples of what the X could stand for is sustainability, manufacturing, cost or assembly. At the start of a product development project, one should be aware of which of the X's are the most important for the specific case, as it can differ quite a lot. Product development is an iterative process with many tradeoffs to be taken into account. Using this approach early on in the development, one could achieve more effective solutions of satisfying the different X's. Unlike some traditional design methodology, using DfX can align the design team with for instance the manufacturers and logistics and therefore encourages the cooperation with those who will be involved handling the product before it reaches the customer. [5]

2.2 Biophilic design

Biophilia, the love and craving for nature itself. The term is based on the human need to connect with nature in order to thrive and was coined in 1964. Later, biophilic design was defined by Dr. Stephen R. Kellertas, incorporating multisensory design to reconnect people with nature despite the ever evolving urbanisation. Some examples of using biophilic design can be maximizing natural light, using natural materials such as wood or stone, incorporation of plants and using color palettes associated with the outdoors.

It has been proven that environments that provide natural elements, thus incorporating biophilic design, have a positive impact on both physical and mental health. For instance, research was conducted that showed that patients with access to view of nature healed faster and had less need for pain medication due to the view resulting in less stress.

The trying times of the COVID-19 pandemic lead to an acceleration of the already rising trend of biophilic design. One of the most noticeable trends being how many people took up gardening or plant care as a hobby and how hiking and experiencing nature first hand increased. These activities have a correlation with experiencing less anxiety and stress. Now, with the world slowly returning back to normal after the pandemic and its consequences, the use of biophilic design is more important than ever, both in private as well as public spaces. [39]

2.3 Product development at IKEA

IKEA has a way of working which is unlike many other companies. This is reflected in the methodology which new products are developed as well. Though many of the activities performed by the IKEA product development teams can be recognized in other known methods, they are still implemented the IKEA way and the company has its own methodology which will not be disclosed. However, the emphasis lies on creating a better everyday life for the many people, using the Democratic Design principles and thriving to achieve circular products.

2.3.1 IKEA Culture and Values

Everything at IKEA is highly dependent on the IKEA culture and values. The 8 key values at IKEA are: Togetherness, Caring for people and planet, Cost-consciousness, Simplicity, Renew and improve, Different with a meaning, Give and take responsibility and Lead by example. Though IKEA is a global company with countless of employees, they have managed to unite all different kinds of people through these key values. [30] Though one might not think about culture and values as something that would affect the product development process much, it is so deeply ingrained in the company that it has direct correlation to creativity and decision making, thus making it a crucial part to learn and embrace as well.

2.3.2 Democratic Design

The Democratic Design (DD) principles are essentially the boiled down and applicable way of using the IKEA values to create products. Much like Design for X, the Democratic Design principle helps to focus on set traits a product should have by the end of the development process. The five pillars of Democratic Design are form, quality, function, low price and sustainability and are visualized in the figure below. Despite the term being relatively new in comparison with IKEA itself, one can see that these principles only emphasize the values that have been essential to the company from the very beginning. [24]

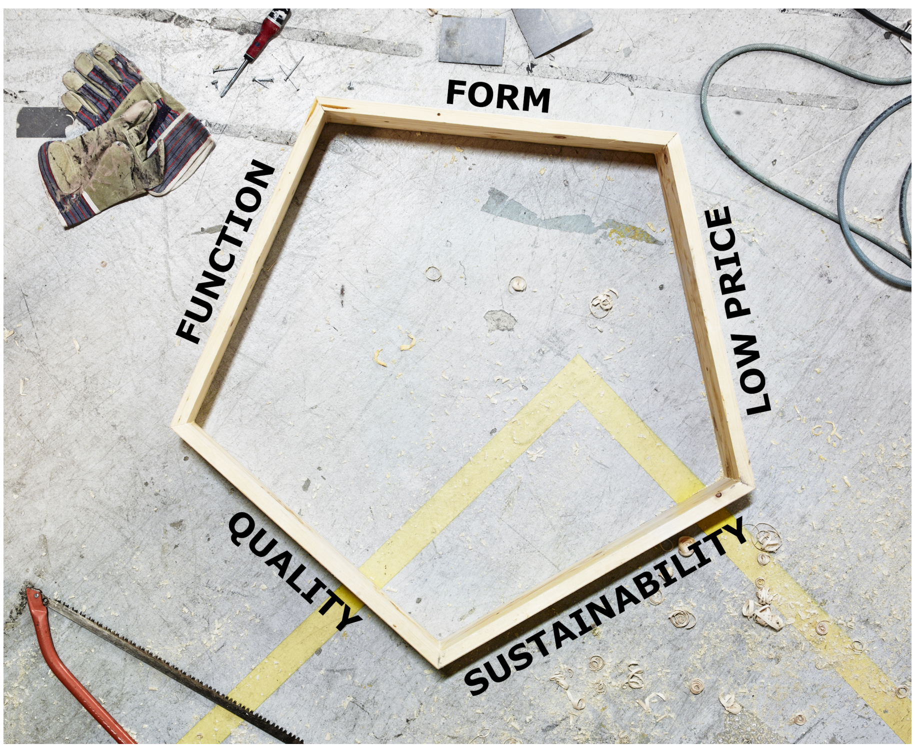

Figure 3: *Visualization of the Democratic Design principles. [26]*

Diving further into the meaning of Democratic Design and its likeness with Design for X, one could say that the five DD pillars are goals that cannot be neglected to satisfy others. Finding the balance can be complicated, but is a nonnegotiable part of the development process, and each one has a different meaning for the product. The form represents the aesthetic and is what people see and can hopefully picture themselves having, providing the joy of having a beautiful home. Of course, the product has to meet some need in the intended space, and therefore its function is important. A functional product is a used product. For the product to be continuously used and be able to last for a long time, the quality cannot be forgotten. Needless to say, if the low cost has not been achieved, it is harder to reach the many people and provide the better everyday life. Last but certainly not least, the aspect of sustainability is probably the most multifaceted of them all. The responsibility which arises when making sustainable choices follows the product through both time and different directions before, during and after its use. [23]

2.3.3 Circular IKEA

As many other companies profiled towards a customer, IKEA has had a linear profile in the form of ’take, make, waste’. Though a lot has happened throughout the years and certain measures have been implemented to for instance use more recycled materials, this is not enough for the planets finite resources. The goal for IKEA is to reach full circularity by the year 2030, ending the cycle of linearity and entering the one of circularity. In 2019, IKEA released a document containing guidelines for how this can be applied during the development of products. To define the new, circular IKEA, four closed loops were introduced: reuse, refurbish, remanufacture and recycle. As can be seen in figure 4, design guidelines correlating to the circular loops have been added to the Democratic Design pentagon as an extension of the existing five pillars. [21]

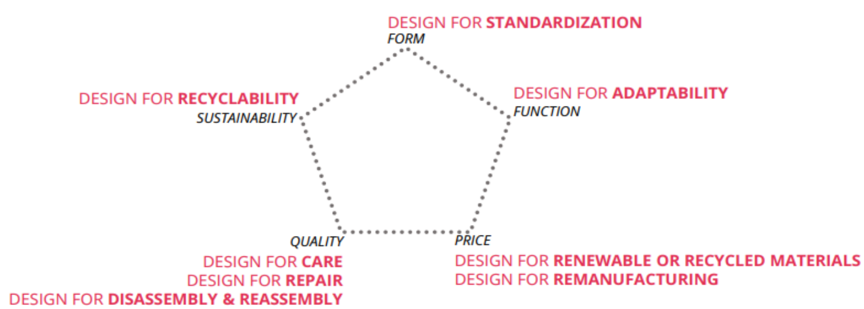

Figure 4: *Design guidelines for circularity, extending the Democratic Design principles. [21]*

3 Research

To learn about the needs of the product, research was done to get familiar with planting and self watering as well as the needs of the customer. The learning and activities in this chapter were performed iteratively with the brainstorming of concept ideas that will be presented in the next section.

3.1 Planting theory

As mentioned earlier, biophilic design is the inclusion of different natural elements, which for this project will be the living plants growing in the planter. Therefore, understanding the need of the plants is important as their well being will directly affect the style and mood of their environment.

3.1.1 Self watering definition and mechanisms

Contrary to the implication of the name, a self watering planter does not water itself. Instead, it allows plants to take up water from a provided reservoir, allowing for a consistent soil moisture level which the plant has more control over. The caretaker of the plant must therefore refill the reservoir from time to time, but this method can be helpful in preventing over watering. It is also more intuitive to fill an empty container with water rather than knowing when the plants are in need of watering. [1] A more accurate term could be effective watering or plant intuitive watering, but for the sake of this project the mechanism will continue to be referred to as self watering.

The method of self watering uses the principles of capillary action, also called capillary rise or wicking. The latter naming is often used when referring to self watering. This phenomenon is when liquid rises or flows in narrow spaces without the effects of gravity or other external forces, sometimes even opposing these forces to ascend. Capillary action can occur in for instance thin tubes, porous as well as some nonporous materials and in cells. The rise is the result of the liquid's surface tension and the adhesive force between it and the surrounding material enabling the liquid to climb if the diameter where it resides is small enough. Moreover, capillary action is what enables plants to take up water from their roots during transpiration all the way to each leaf tip. Furthermore, it is this phenomenon that will also ensure the consistent moisture level of the soil, as the water will also climb this material due to its porosity. [40]

Though the principle is the same, there are different ways of utilizing capillary action to achieve self watering. Three methods this project has focused on are wicking baskets [13] or containers, wicking strings and lastly wicking tubes. More complicated methods, utilizing electricity, pumps, hoses or alike have been excluded from the span of this thesis and the reason will be further explained later in section 4. [6]

3.1.2 Plant health with self watering

Much like the people who care for them, plants have varying needs. Though one can try to accommodate to as many different plants as possible, unfortunately it is impossible for a solution to fit all. Most self watering mechanisms are efficient for plants which like constant conditions like evenly moist soil, some examples are herbs, vegetables, perennials and annuals. Plants requiring large amounts of water might not benefit as much, like the fiber-optic plant or certain palms. [4] And finally, plants who thrive when letting the soil dry out regularly, like succulents and cacti, are not recommended when using self watering planters. [3] It should also be noted that the self watering mechanisms do not take into account the environment the planter is in. As the consistency of the water will remain the same, humid or too rainy environments might lead to overly watered plants. [4]

3.1.3 Planting materials and soil

When buying a plant, it will most likely come in a nursery pot, that being the pot it has grown in at the plant nursery. [36] These pots are often made out of some sort of plastic, like polypropylene (PP) or polyethylene (PE). [11] These specific types of plastics are often used for planting and gardening overall, not only for the nursery pots. The reason for their frequent use is for instance their tolerance for temperature changes, UV-resistance and overall structural stability. PP and PE are also classified as food safe plastics, which also qualifies them as safe for plant care. [12] It is usually not necessary to replant plants from the nursery pot until the roots are outgrowing it, and these can therefore be put in decorative planters directly after purchase. [36] It is rather debated whether plants should be repotted into decorative planters without drainage holes, but many people argue that as long as some aerating additive such as perlite or vermiculite is added to the soil no harm will come to the plant. [35] Though problems can arise without the aeration, this is mostly true when plants are watered from above. However, as mentioned earlier, capillary rise will occur when the medium for the liquid to travel in is rather porous. [40].

As of today, IKEA offers a large variety of both plants and decorative planters. For the pots that are intended for outdoor use, the materials differ quite a lot. A majority are made out of either metal, plastic (PP or PE) or ceramics like terracotta or glazed stoneware. [29] Material choices are further brought up in section 4.2.

3.2 Customer needs

To achieve a functional product, one must first identify the customer. Both customer and intended market had been mapped by IKEA before the start of the project and applies to the entire product family. Before continuing, it must be mentioned how many details in this chapter can unfortunately not be disclosed according to the confidentiality agreement. This includes descriptions of the intended customer. Methods and decisions for listing and ranking the customer needs can therefore only be vaguely described.

At first the thought was to perform an observation study of different outdoor planters that potential customers already possess. Unfortunately, the span of this thesis has been during the Swedish winter and not many people have their plants and pots outside during the cold months. Instead, simple interviews were held with people in the intended target group, there were four participants.

An ideation session took place with the rest of the development team. Using a shared visionboard, customer needs were brainstormed for the entire product family. Of course, only the ones relevant to the planter will be presented. By performing this activity with the PD group, many valuable insights as well as improved understanding of the entire project could be achieved.

Additionally, a meeting with a Product Design Engineer specifically working with pots and planters was booked. This meeting proved to be helpful in several ways and helped move the project forward. Summarizing, she could confirm the importance of some aspects that had already been thought of, such as the need for drainage and material choice. Thanks to her many years of experience working with Decorations as well as by sharing a co-creation [22] done on planters, inspiration for several important customer needs could be obtained.

3.3 Product requirements

Now, expanding on what features the product should have, the requirements should also be discussed. These are more related to laws and regulations rather than problem solving as the needs are. As this project is intended for outdoor use, some regulations are stricter than for a product used indoors. For instance, the product would need to withstand UV-radiation for it to pass outdoor tests. IKEA has a policy of following the strictest form of regulations to enable safe products that can be used all over the world. Many requirements are both complicated and come further down the line of development and will therefore not be considered, but the principle is important to mention.

3.4 Specify and rank customer needs

The following table lists the interpreted needs of the self watering planter. Some of the needs stated have the entire structure in mind and not only the self watering insert. Additionally, the table also shows whether the need is one of the customer or if it is a requirement, and as can bee seen, some coincide.

Need#	Need	Customer	Requirement
1	Easy to clean		
2	Easy to store away		
3	Easy to move		
4	Easy to plant		
5	Easy and intuitive to water		
6	Require less frequent watering		
7	Visually pleasing/beautiful		
8	Not be in the way		
9	Sturdy/hard to knock over		
10	Not leak uncontrollably		
11	Easy to assemble		
12	Easy to disassemble		
13	Prevent danger for people		
14	Tolerant to different environments		
15	Easy to manufacture		
16	Easy to transport		
17	Prevent overwatering of plants		
18	Prevent overheating of plants		
19	Prevent freezing of plants		
20	Prevent root rot		
21	Collect rainwater		
22	Simple water distribution		
23	Not look or feel cheap		
24	Space efficient		
25	Create room in room		

Table 1: *Compilation of customer needs.*

In table 2 below, the needs stated in table 1 are ranked in order of importance. Each need has been assigned a number between 0-5, a high number meaning high importance. Note how the needs that are ranked the highest are the ones that when fulfilled will create a product that has followed the Democratic Design principles, including the circularity criteria. It should also be mentioned that some of the needs that are more related to the entire structure, that is including the decorative planter or the fence, have been ranked with the lowest importance due to the irrelevancy of this project. Of course these should not be neglected overall, but the focus will continue to be on the self watering insert.

Importance 0-5	Need #	Need
5	1	Easy to clean
5	11	Easy to assemble
5	12	Easy to disassemble
5	16	Easy to transport
5	22	Simple water distribution
5	15	Easy to manufacture
5	17	Prevent overwatering of plants
5	18	Prevent overheating of plants
5	19	Prevent freezing of plants
5	20	Prevent root rot
5	13	Prevent danger for people
4	5	Easy and intuitive to water
4	6	Require less frequent watering
4	14	Tolerant to different environments
3	3	Easy to move
3	2	Easy to store away
3	4	Easy to plant
3	10	Not leak uncontrollably
2	24	Space efficient
1	21	Collect rainwater
1	8	Not be in the way
0	23	Not look or feel cheap
0	9	Sturdy/hard to knock over
0	7	Visually pleasing/beautiful
0	25	Create room in room

Table 2: *Ranking of the product needs based on importance.*

3.5 Benchmarking

Before starting to generate ideas and concepts, some benchmarking needed to be performed to get some insight and knowledge of existing products and the market. This was done as both an internal and external search.

3.5.1 Internal benchmarking

Researching internally for existing solutions can provide with ways of designing for easy manufacturing, transporting, low cost and circularity overall due to the existing knowledge of the offered products. For instance, using the same manufacturer for similar pieces can cut the cost of both products due to bulk ordering. Though the IKEA range offers many decorative planters and plants, only one has the function of being self watering today. IKEA PS FEJÖ is a beloved staple of the PS collection and has been sold for over 20 years. The figure below shows more of the well known PS products as they were presented in the IKEA catalogue of 2003. The reason why there still exists a need in the range for this project is that PS FEJÖ is not officially approved for outdoor use.

Figure 5: *Excerpt of the IKEA 2003 catalogue, with PS FEJÖ among other products of the years PS collection. [16]*

The planter has been updated in some ways over the years, but has largely stayed the same as the original design by Thomas Sandell. Over the years it has been available in white, light green, blue and black. Its predecessor without wheels called HYDRIA can be spotted in the 1998 IKEA catalogue as seen in figure 6.

Figure 6: *Snapshot of the IKEA 1998 catalogue, with PS FEJÖ's predecessor HYDRIA. [15]*

PS FEJÖ uses the wicking basket method with the water reservoir being directly under the plant placement. Though one can place a nursery pot in the planter, due to the placement of the watering tube, it will not be a space efficient solution and planting with soil directly into the pot is the more popular option. This option also makes use of the sunken part of the wicking bottom layer. See figure 7.

Figure 7: *Watering demonstration and bottom insert of PS FEJÖ. [25]*

Over the years, more options of self watering planters have been offered at IKEA. NEKTARIN was a self watering insert while JUBEL, GRÖNPEPPAR and SÖTCITRON were complete solutions. Much like PS FEJÖ, NEKTARIN and GRÖNPEPPAR used the method of a wicking basket bottom for the self watering mechanism. JUBEL and SÖTCITRON on the other hand both used a wicking string. Overall, their likeness was the small size that was fit for indoor use. Figures 8 to 11 show these products in order of presentation as they were introduced in the IKEA catalogue their respective years.

Figure 8: *IKEA NEKTARIN from the 2010 catalogue. [17]*

Figure 9: *IKEA JUBEL from the 2013 catalogue. [18]*

Figure 10: *IKEA GRÖNPEPPAR from the 2015 catalogue. [19]*

Figure 11: *IKEA SÖTCITRON from the 2016 catalogue. [20]*

3.5.2 External benchmarking

Benchmarking self watering solutions externally led to different products using practically the same principals as found internally. Examples of these similar solutions can be seen in figures 12 to 14. Figure 12 shows an insert for indoor pots, the one in figure 13 can be used flexibly due to a bottom plug. Lastly, the Lechuza planter in figure 14 comes equipped with substrate and uses string wicking, it can withstand UV-radiation and frost, but does not seem to have draining possibilities.

Figure 12: *Insert solution from Elho. [9]*

Figure 13: *Complete solution from Elho. [8]*

Figure 14: *Complete solution from Lechuza using wicking string and substrate. [14]*

An interesting solution can be seen in figure 15. The product called Minigarden has a detachable watering tank instead of the water reservoir being under the plants, and it has to be removed to be refilled. The tank itself is connected to a textile cloth which the pots are resting on. Even though the principle of capillary action is still in use, this solution is the most particular one.

Figure 15: *Complete modular solution using textile cloth for water distribution. [32]*

Larger structures also needed to be looked into more. The Elho planter in figure 16 for instance is a rather large product with a water tank holding up to 10L. Continuing, with similar water tank inserts adjusted for each planter, a company called Nola delivers large planters specifically for public use. Their business idea is to work close together with city planners and architects and two of their rather large planters can be seen in figures 17 and 18. As no other recommendation is stated, it seems that planting directly into the planters is necessary for them to function properly.

Figure 16: *Complete outdoor solution from Elho. [7]*

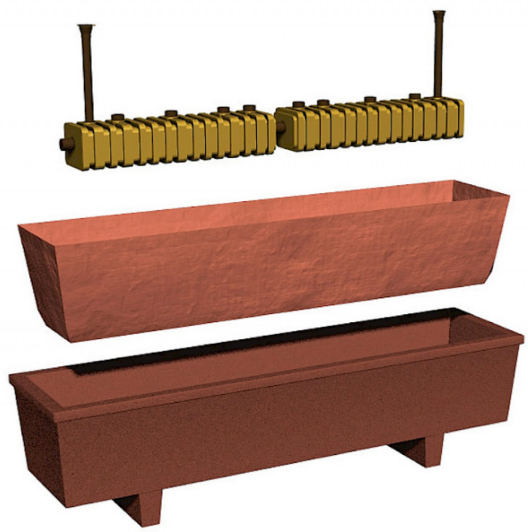

Figure 17: *Complete rectangular solution with self watering tank insert from Nola. [33]*

Figure 18: *Complete round solution with self watering tank insert from Nola. [34]*

Following are some rather complicated watering solutions that exist on the market. They are not complicated in the sense of user friendliness, but they consist of many parts and some are even dependent on constant external water supplies. The following products use variations of drip irrigation hoses; GoGro uses a water tank placed higher than the planters so that gravitational forces lead the water to the hose system, see figure 19. Gardenas modular vertical gardening product has to be attached via garden hose to a running tap and can be seen in figure 20. The product from Rainpoint in figure 21 uses an electrical pump plugged into an outlet and is also connected to an app.

Figure 19: *Connectable drip irrigation by GoGro. [10]*

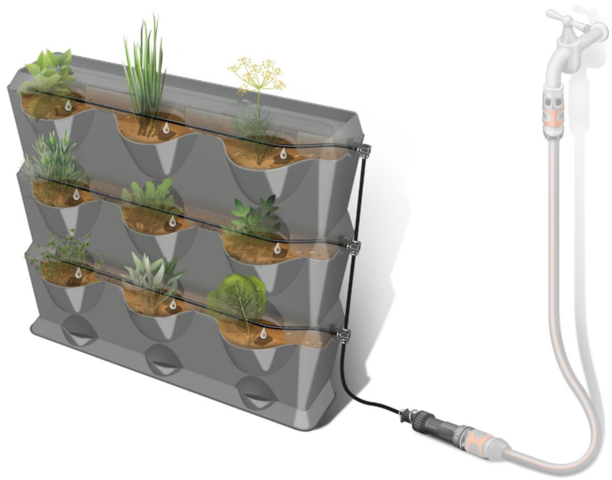

Figure 20: *Vertical gardening solution with drip hose solution from Gardena. [37]*

Figure 21: *Automatic solution by Rainpoint using drip irrigation hoses and a Wi-Fi connected app. [2]*

4 Concept generation

In this chapter, the activities leading up to a final concept selection are presented. The choices and activities were performed in an iterative way and not in the seemingly chronological order they are presented.

4.1 Direction

Combining the identified customer needs and the research of existing products, it was clear that the next step for the project was to set a direction for the development. Though it could be innovative for IKEA to use some of the more technically advanced solutions, the low-tech direction was chosen immediately. The reason for this harsh decision has to do with both the customer as well as the IKEA profile.

First of all, during early consultations with the PD team it was clear that though the regulations and requirements for all products are strict; the ones with electricity involved are even stricter. Consequently, a combination of water and electricity would be particularly difficult to execute.

Second of all, IKEA has a goal to reach the many people. This led to options that required any type of constant water supply to also be ruled out, for it is not given that the customer will have access to a running outdoor tap. Especially in urban, densely populated places, the owner of the product might share the outdoor area with others.

Last of all, only by applying the IKEA values earlier mentioned, it is clear that the low-tech direction is obvious. Simplicity, Caring for people and planet and Cost-consciousness can unfortunately not be fulfilled by creating a complicated product, at least not in the short time period of this thesis project.

4.2 Material choices

There are many aspects to be considered for the material choice. It is important to remember that as many choices within product development, this is also a matter of weighing tradeoffs. Another aspect that heavily impacts the choice is of course the planter being part of an entire product family, meaning the need for familiarity and unanimous choices between the different products. Although it is important to remember that the focus lies on the self watering mechanism, which on its own will most likely not be what catches the eye of the beholder, it must therefore be designed in a way to either fit the aesthetic or be hidden enough from spectators. When choosing materials for products that will be used outdoors, the resistance to climate is highly prioritized. IKEA being such a global company needs to take into account the weather conditions for many different geographical locations to meet the needs of the many people. On the topic of needs, the material choice is highly affected by the activities of the intended customer, therefore some arguments for this choice cannot be presented in the following sections.

4.2.1 Excluded materials

Fragile materials like glass och ceramic were not chosen for many reasons. For one, ceramics can unfortunately not be recycled and using these materials makes it difficult to have spare parts.

As for natural materials such as wood, though it is a more durable and sustainable material, the need for sanding and oiling or glazing about once a year would be complicated to do for the customer. Assuming they buy several planters, have many plants and perhaps even other outdoor furniture, maintaining all of the products would be rather time consuming. Perhaps this is not something everyone can afford to spend time on, and they would want to prioritize the furniture and living plants and not the planters. If not handled properly, the wooden products could also age noticeably faster and most likely lead to replacements. Moreover, wood needs to be treated in order to prevent rotting, and this is difficult to do regularly since the planter is assumed to hold wet content at all times. This could prove fatal for the living plants. Also, if not carved out of one piece, it is difficult to prevent leaking when using wood while still maintaining simplicity.

When it comes to metal, the same as the latter argument for wood are applied; it is not optimal for leaking unless made out of one piece. Although this could be achieved using some molding method in manufacturing, metal is not an optional planting environment for all plants. Furthermore, when it comes to sunny climate, a metal container can reach rather high temperatures and burn the plants from the roots.

Lastly, it should be mentioned that while the listed materials have been excluded, this is for the choice of the self watering insert. Perhaps long term treated natural materials or some sort of metal can be used for the decorative part of the planter, but since it is not the focus of this project, it will not be discussed further.

4.2.2 Plastic

The inevitable exclusion method led to plastic being the reasonable option for the product. This is not surprising when looking at the products in the benchmarking research were a vast majority are made in plastic. It is important for the longevity of the product for the plastic used to be UV-resistant and frost tolerant. By using a high percentage of recycled plastic and developing for and encouraging proper recycling, the product can be one step closer to reaching circularity.

IKEA has experience working with several suppliers offering different manufacturing options for plastic products, making it a question of form whether it will be easy to manufacture or not, as the competence already exists. Examples of different manufacturing methods for plastic materials are 3D-printing, laser-cutting and injection moulding. The planter insert will most likely benefit the most from being made with either PP or PE plastic as these are the plastics used for outdoor pots in the range today.

4.3 Brainstorming

For this project, the brainstorming was performed for small sprints over several weeks, parallel and iteratively to the research. These were all performed individually. Starting with a simple sketch, if the idea seemed feasible it was also modelled in SolidWorks for a better overview. At first, the line between the self watering insert and the structure as a whole was rather unclear, and therefore some early concepts visualize not only the decorative planter but in some cases also some sectioning ideas.

4.4 Sketches of concepts

The first concepts, figures 22 and 23, presented below show ideas centered around the entire structure, almost entirely focusing on the fencing, which for this project is not really relevant and are therefore dismissed directly.

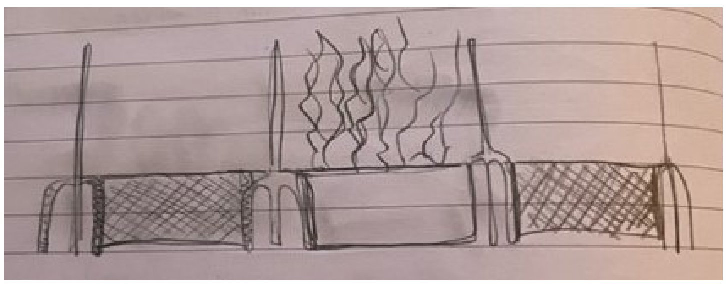

Figure 22: *Concept A, complete sectioning solution with large planter.*

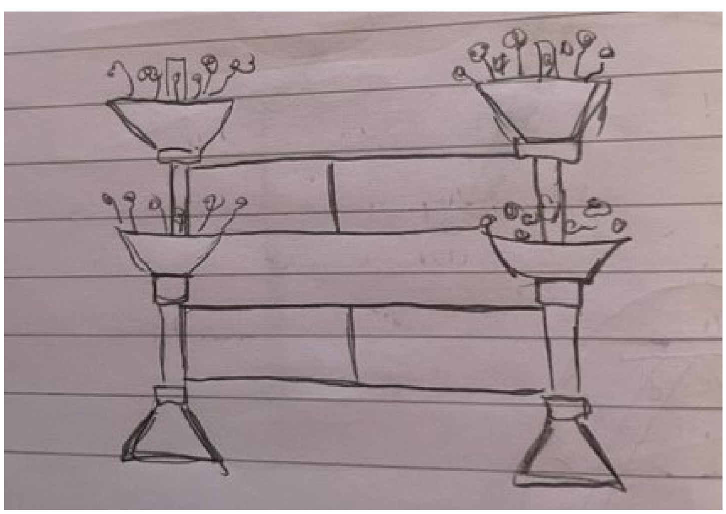

Figure 23: *Concept B, complete sectioning solution with smaller planters.*

An important feature for the outdoor planter is to drain properly without emptying the water reservoir used for self watering. Figure 24 shows a sectioned view of a sub-concept for a draining solution. This solution positions the outlet opening high enough for there still to be room for a reservoir, and empties the overflowing water under the bottom of the structure.

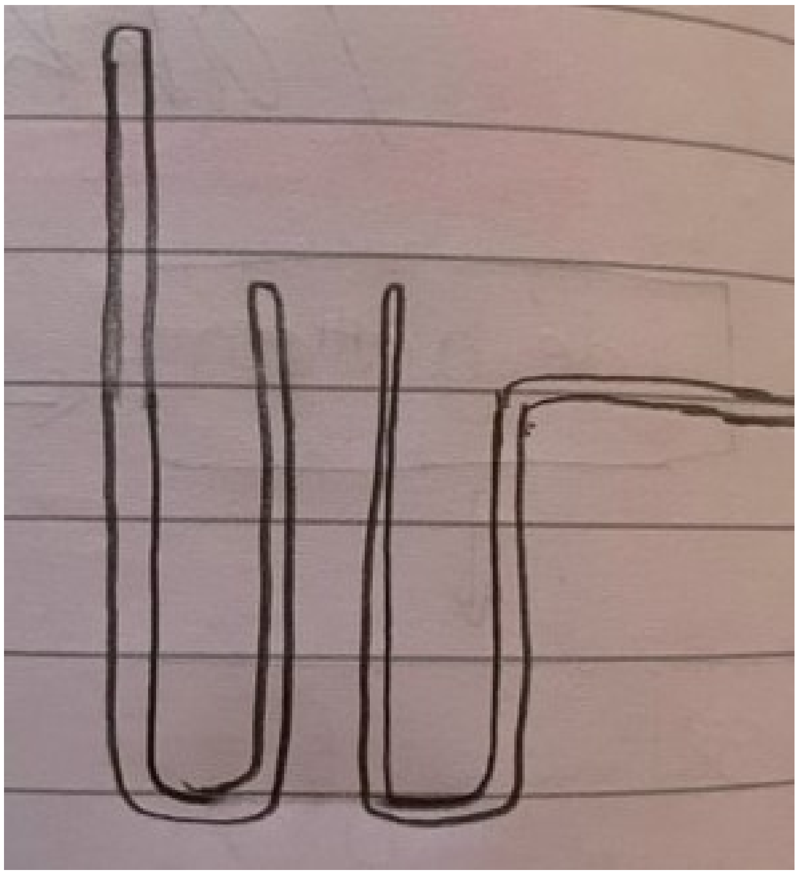

Figure 24: *Sub-concept for draining solution.*

Concept C below consists of an outer and an inner, removable part of the self watering insert. It creates a structure with double walls that act as the water reservoir and has a top part with holes to let rainwater come into the tank. The bottom of the inner part has holes for wicking.

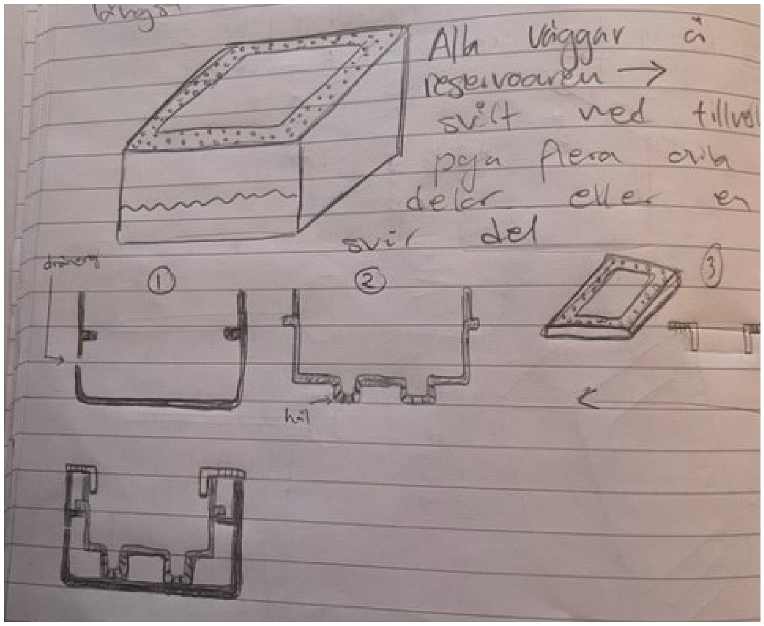

Figure 25: *Concept C, solution in three parts.*

Similar to concept C, concept D in figure 26 is divided into an outer part and an inner, closed, adjustable tank. For stability, some weight should be permanently fixed to the bottom of the structure.

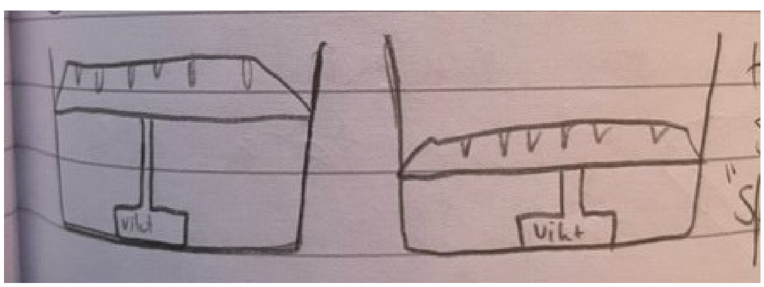

Figure 26: *Concept D with adjustable water tank.*

Concept E seen in figure 27 uses the string wicking method through a long tube connected to the water reservoir which also acts as a ground stabilizer for the product. The string could potentially be unnecessary if the tube has a diameter small enough for capillary action. This concept would not require outer decorative planters as it stands alone.

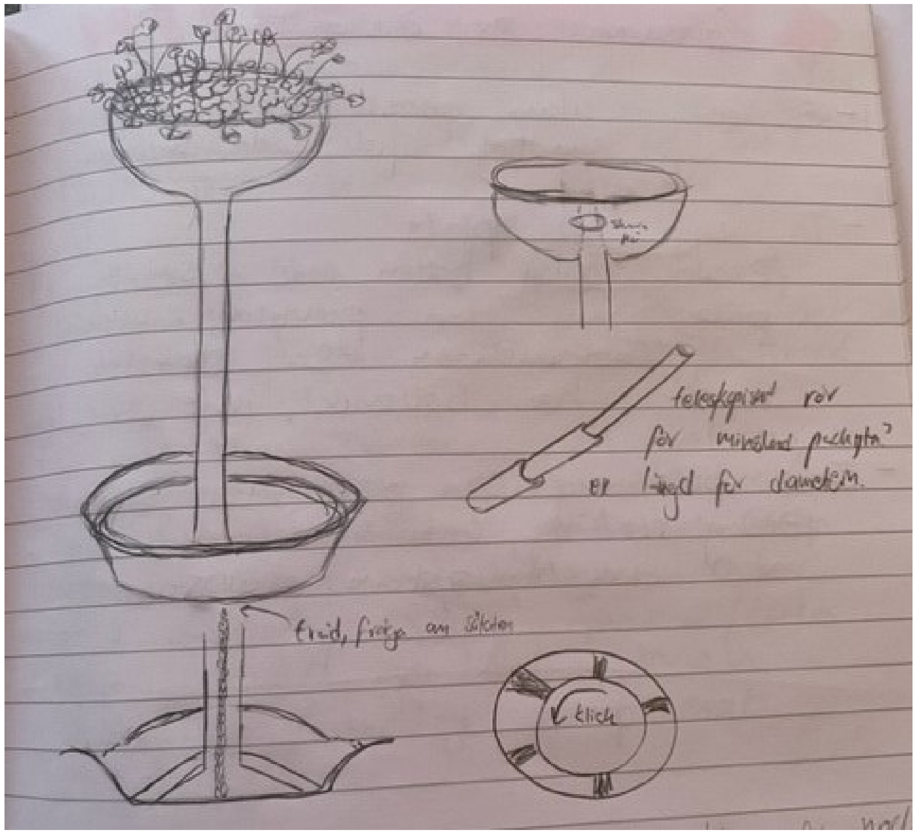

Figure 27: *Concept E, solution using wicking string.*

Concept F shows a simple watering insert connected to a fence. The fence itself is the transportation system for the water to travel to all connected pots. Again the tubes would need to have quite a small diameter. See figure 28.

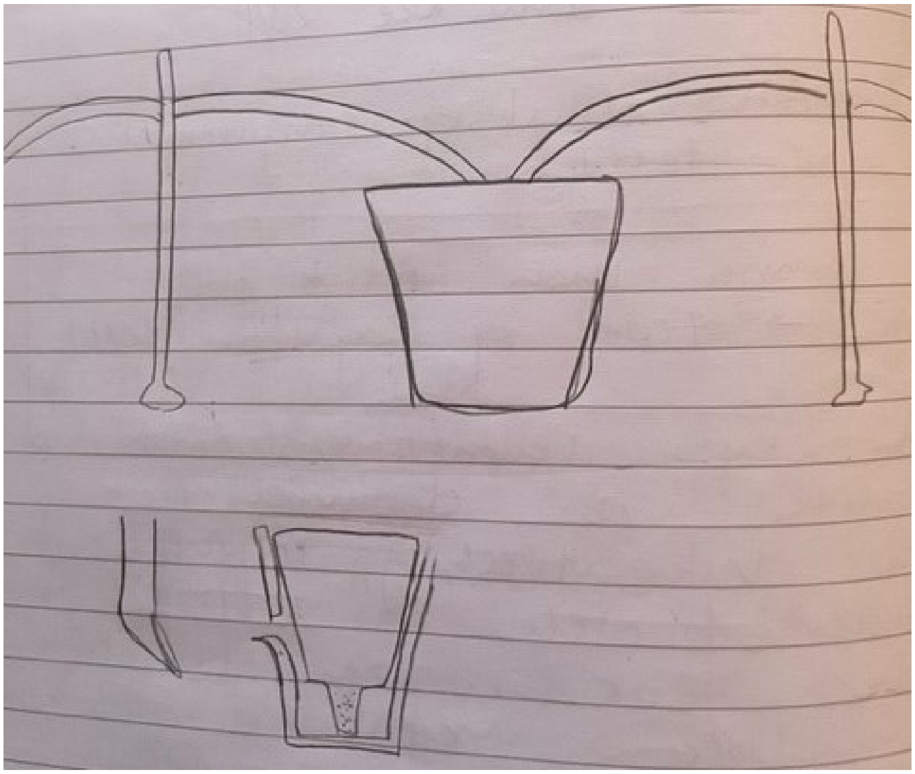

Figure 28: *Concept F, fence provides water distribution.*

Concept G below, figure 29 and 30, is a structure with a water tank placed higher than the plants to let the water fall down and through every connected planter. Each planter has a triple layer structure; reservoir, passage and plant area. The layers work so that the first planter reservoir gets filled with water by the large tank, when its full, the water instead slides down the passage and into the next connected planter.

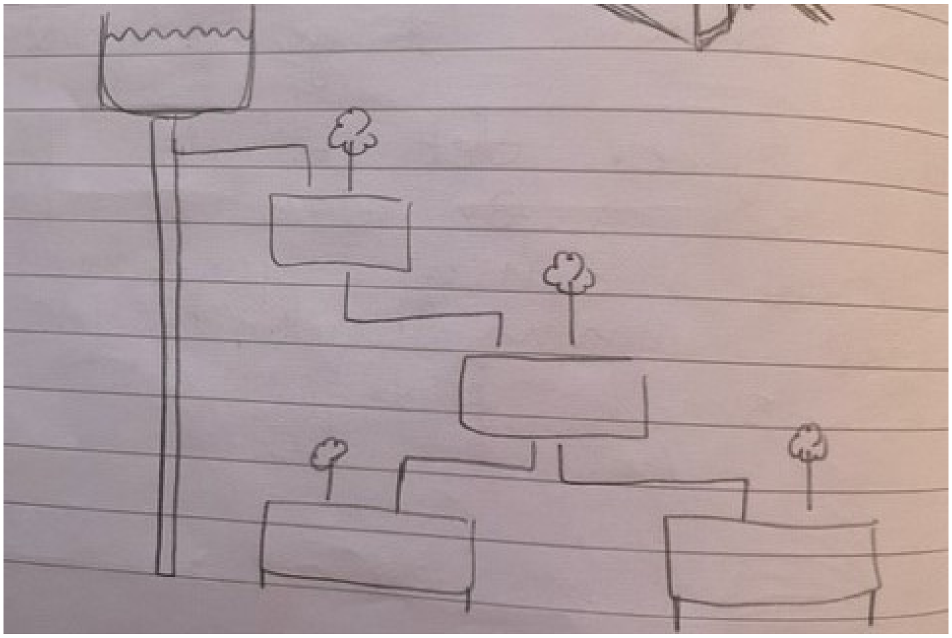

Figure 29: *Concept G, modular solution using gravity to distribute water.*

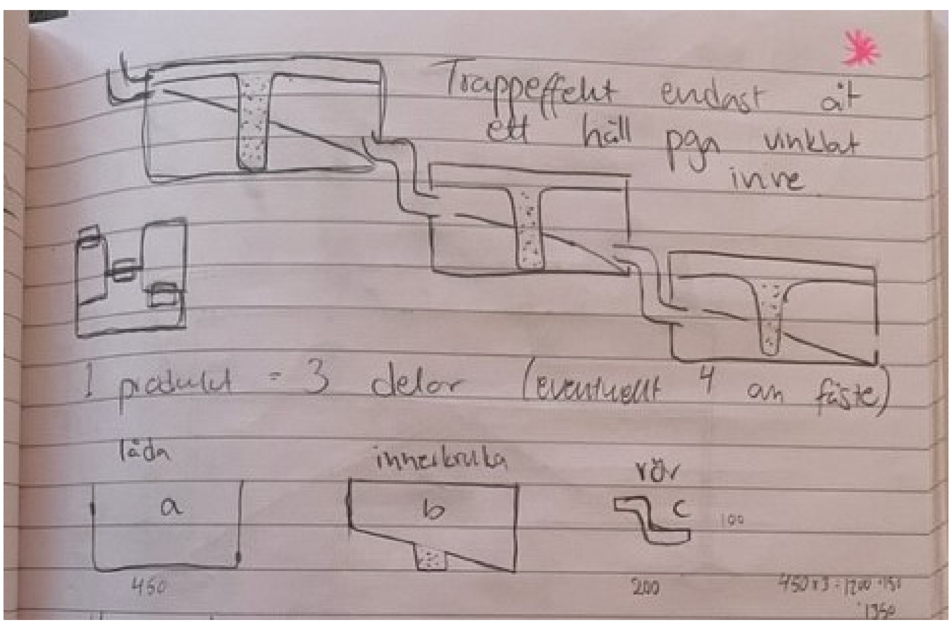

Figure 30: *Concept G, sectioned sketch view.*

The three following figures 31, 32 and 33 below show slight variations of concept H, a rain collecting idea. Figure 31 uses double funnel-like pillars going down into the planter which together hold up a trellis between them. Figure 32 shows a sectioned view of a single funnel leading to a tilted water reservoir, enabling growing plants with different root deepness needs. Figure 33 on the other hand shows only an idea of how the funnel could distribute water.

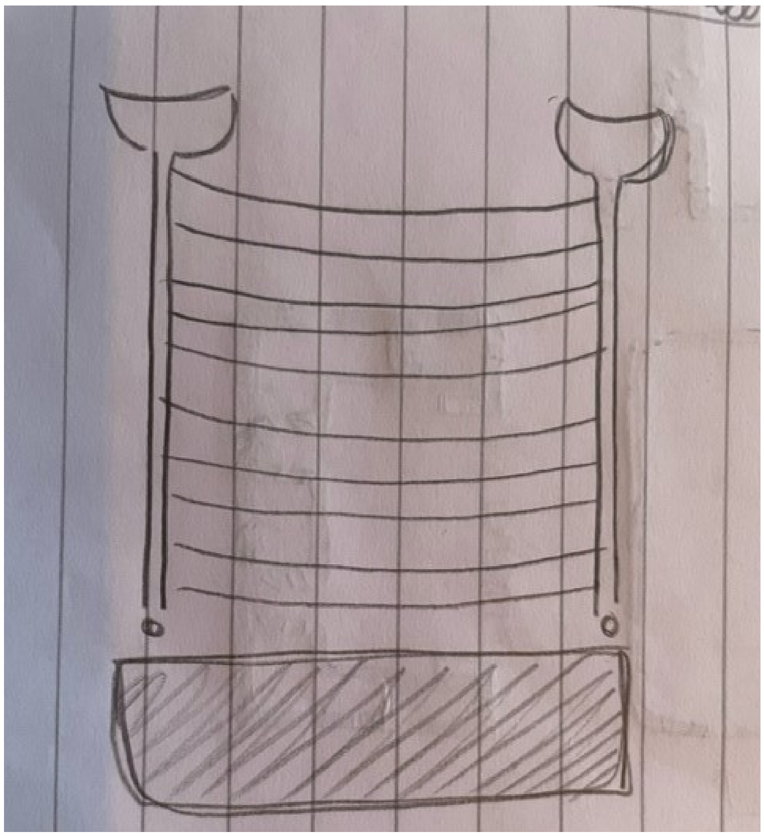

Figure 31: *Concept H.1, double funnel and trellis solution.*

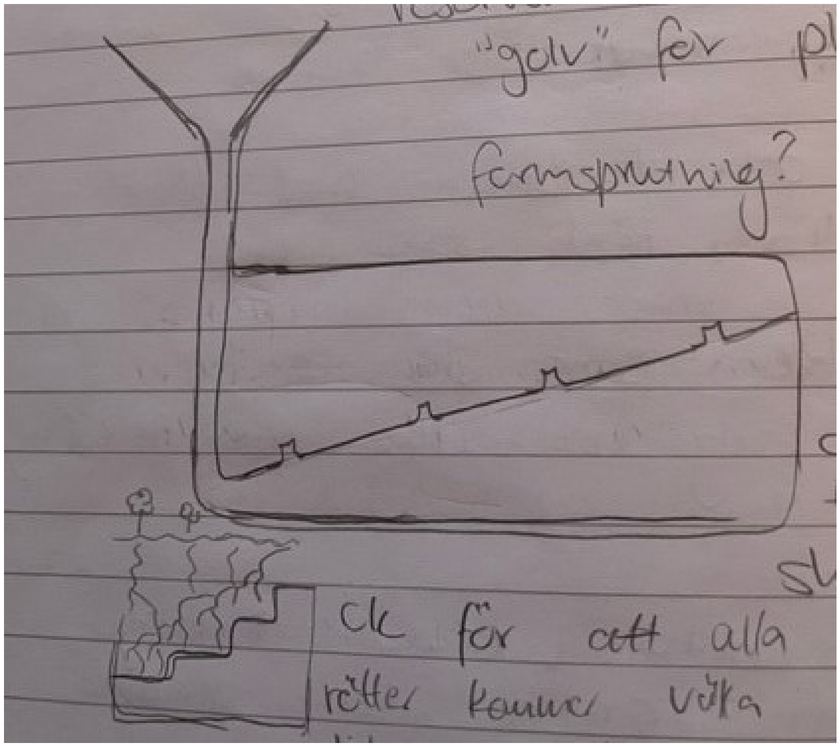

Figure 32: *Concept H.2, funnel and uneven bottom solution.*

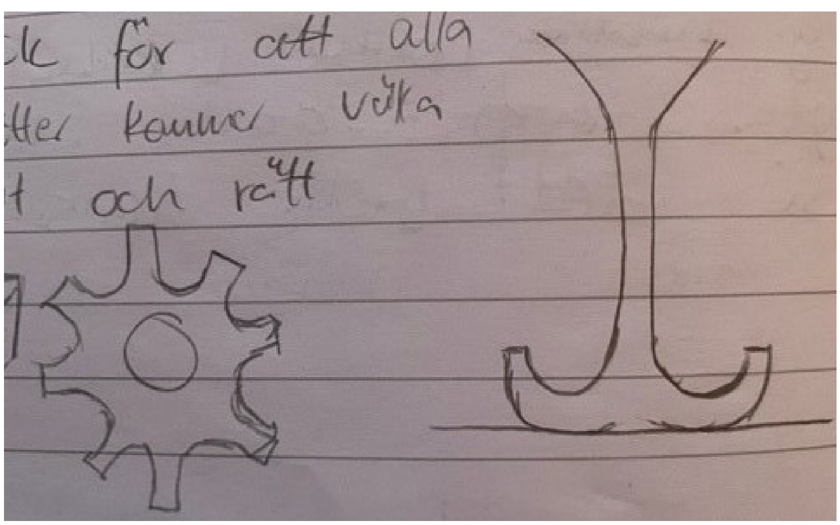

Figure 33: *Concept H.3, funnel distribution sketch.*

Continuing on the note of using rainwater, concept I in figure 34 below uses a flexible hinged opening that leads the water to a water reservoir.

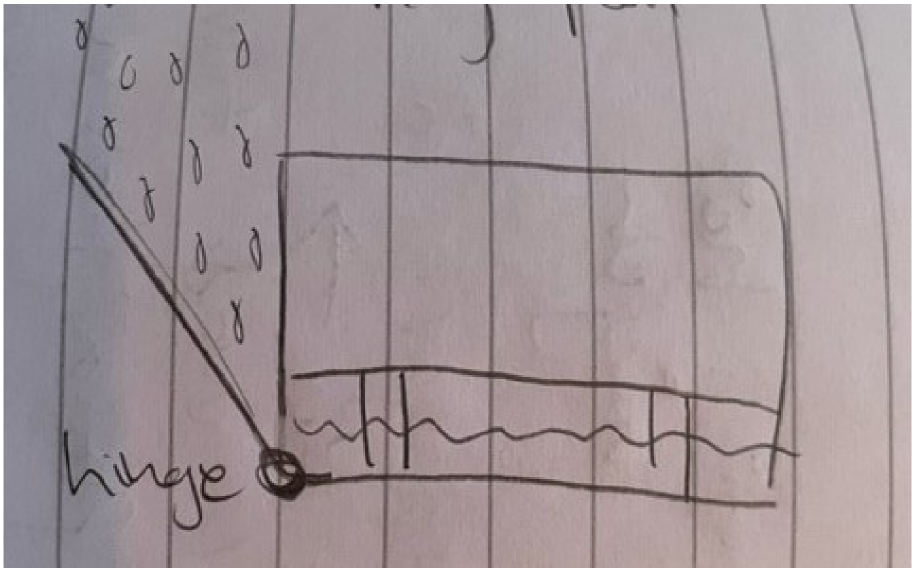

Figure 34: *Concept I, flexible rainwater collector.*

4.4.1 First concept selection

With the ranked needs of table 2 in mind, a first concept selection could be performed to narrow down the options. As already pointed out in the previous section, concepts A and B are not really relevant for the self watering project and were discarded. After some iterative work, it was realized that collecting rainwater was not of high importance. The reason for this being that locations that would benefit most from a self watering solution are often dry, making a water collector an unnecessary addition to the function. This led to all variations of concept H as well as concept I to be dismissed. Thus concepts C, D, E, F and G were left.

4.5 3D-modelling of concepts

To better be able to visualize the concepts left, some of them were modelled using SolidWorks, still on a very conceptual level. Concepts C, E, F and G were modelled as concepts D seemed clear enough already. Images of the 3D-modelled concepts can be seen in figures 35 to 40.

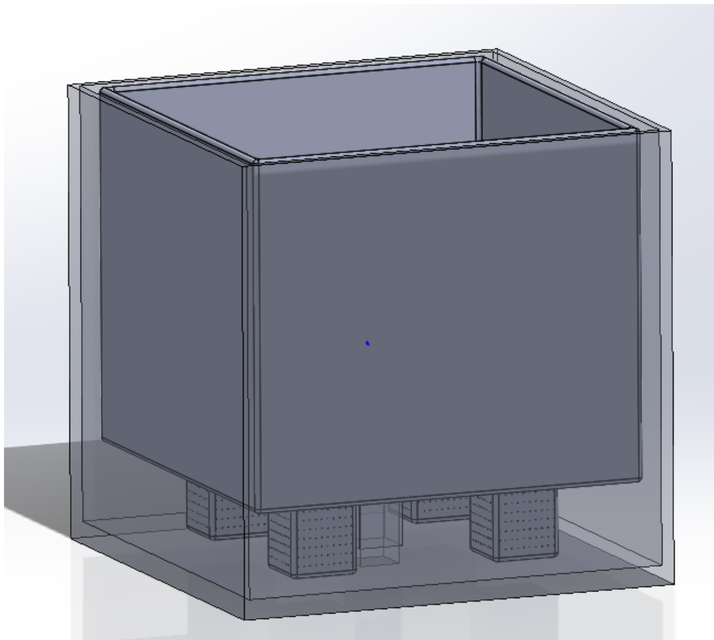

Figure 35: *Concept C using the draining sub-concept from figure 24.*

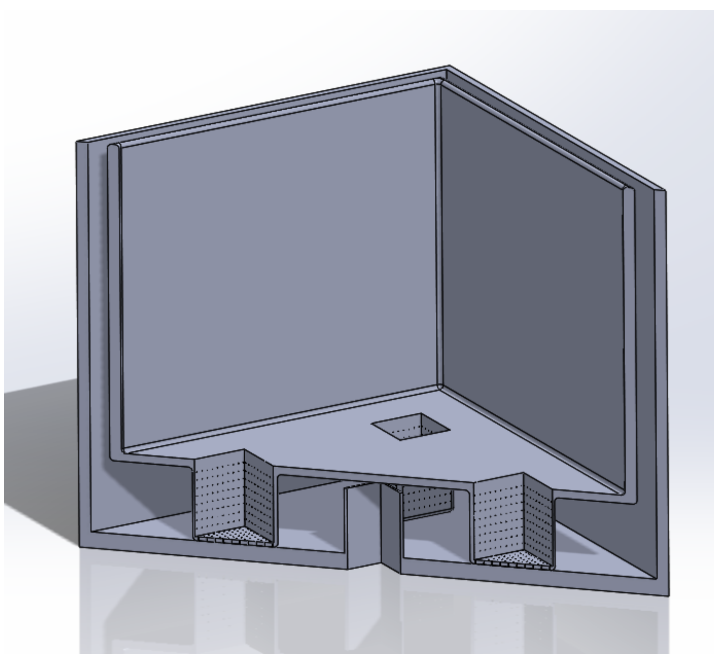

Figure 36: *Sectioned view of concept C.*

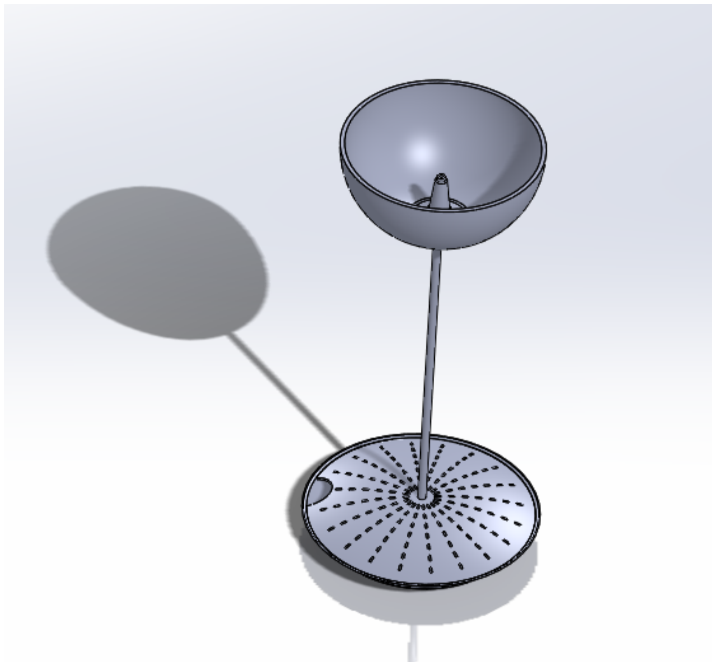

Figure 37: *3D model of concept E, rainwater collecting holes and watering hole added.*

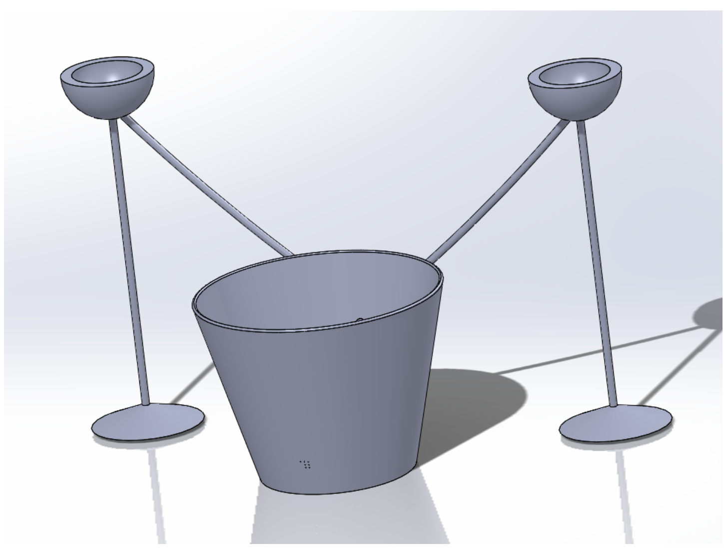

Figure 38: *3D model of concept F, watering cups added to fence as well as small draining holes to the pot.*

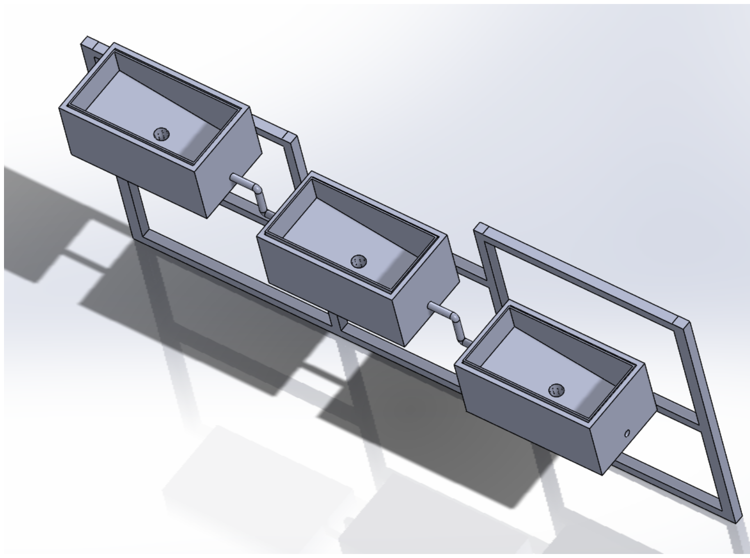

Figure 39: *CAD-model of concept G.*

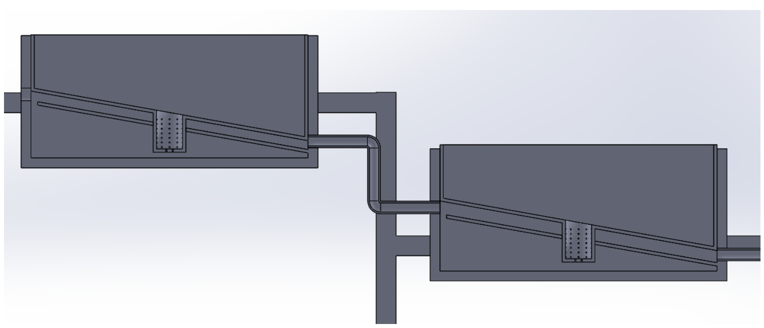

Figure 40: *Concept G, sectioned 3D model.*

4.6 Concept scoring

To chose a concept from the five remaining, the Democratic Design principle was applied as the framework for concept scoring. Many of the needs listed in table 1 are strongly related to the Democratic Design and so will facilitate the scoring without compromising the needs. The DD principles were rated 1-5 for all concepts and their total score reveals if the concept should be further developed or not. Scoring was based on the potential of how easy it would be for the concept to succeed with each principle and is not weighed as all pillars are equally important. All concepts received a Quality score of 2.5 as it is not possible to tell before thorough development and all concepts have the same potential in this aspect. The concept scoring can be seen in table 3.

Democratic Design Criteria	C	D	E	F	G
Form	4	3	4	2	4.5
Function	4	2.5	2	3	4
Quality	2.5	2.5	2.5	2.5	2.5
Low Cost	3	2	2	2	1
Sustainability	3	2	2	3	2
Total Score	16.5	12	12.5	12.5	14
Rank	1	5	3	4	2
Continue Developing?	yes	no	no	no	maybe

Table 3: *Concept scoring of concepts C, D, E, F and G.*

Concept C ranked the highest and was chosen for further development. For concept G, though it scored relatively high points, it also received the lowest internal scoring on one criteria, Low Cost. As previously stated, all Democratic Design principles are equally important, and though concept G has both promising Form and Function, it would need too many internal parts with rather high accuracy for the system to work; making it hard to succeed with Low Cost and Sustainability.

5 Developing final concept

This chapters follows the many steps in developing the self watering insert from the chosen concept idea. The development process continued to be quite iterative, moving forward through trial and error. Some choices and details are left out of this chapter due to confidentiality.

5.1 Scaling

When the 3D models were first being done, concept C received the name "bulk" in the CAD files as it was perceived as quite cumbersome, using a lot of material and overall giving a heavy feeling. As this was thought to be the squared appearance at fault, the first adjustment was slimming in one direction, creating an elongated version. Unfortunately this did not do much for the bulky impression.

5.2 Components

The first sketches of concept C featured three components, an outer and inner container and a rain collecting lid. When 3D-modelling the first setup, the lid was ignored, and yet the product still seemed bulky. The conclusion for this was the double walls for the water containment, and instead, a concept with resemblance to the PS FEJÖ bottom was sketched. Note how the drainage hole is on the bottom, using the sub-concept from the brainstorm.

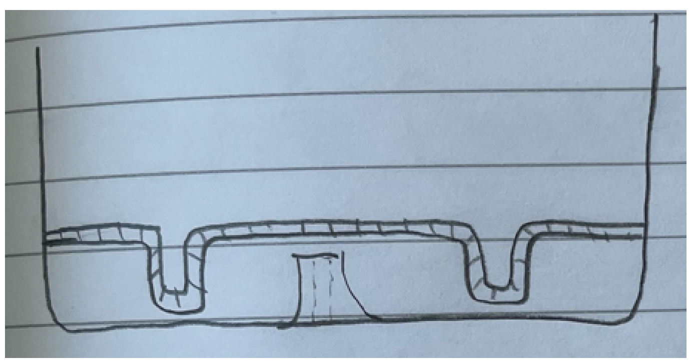

Figure 41: *Concept C with simple inner part.*

Immediately after sketching as shown in figure 41, another realization hit: the wicking will only occur in the sunken "basket" parts of the insert due to the drainage holes placement. This would lead to uneven water distribution if the number of baskets is not increased, but making a more complicated inner part would mean more expensive tooling and overall complicate matters. Instead, a combination of the original idea, figure 25, and the simpler one led to the idea seen in figure 42 below. The idea was sketched both with the bottomdraining concept and the sidedraining from the first sketch of concept C.

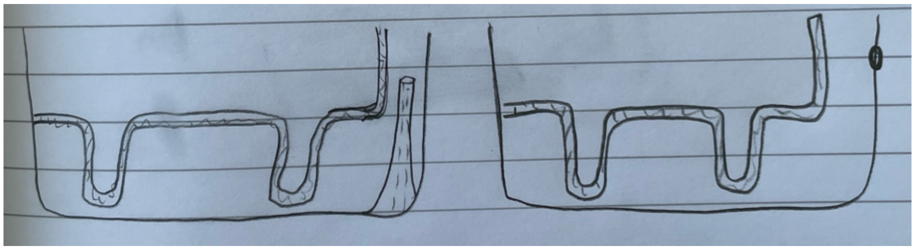

Figure 42: *Combination concept showing two alternatives for draining.*

To further simplify the design, with aspects in mind such as manufacturing, cost and transport, the insert was made completely flat. Together with the draining hole on the side of the structure, this was thought to be the start of a perfect stacking possibility. See simple sketch below. The insert part will from now on be referred to as the L-insert due to its profile form.

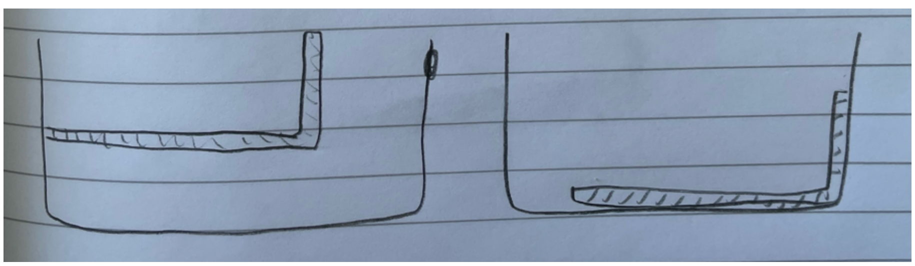

Figure 43: *Flat insert, showed both in use (left) and during transport (right).*

5.3 Stacking

Due to the need of not leaking, at least the outer part of the product was decided to be in one piece. This automatically eliminated the option of the typical IKEA flatpack solution [28], though the next best thing is stackability during transport. For products of the same size to be stackable, the form needs to have a draft angle. This is also needed if components are manufactured using injection moulding, though that will be discussed later.

Unfortunately, another problem appeared when the drafted pieces were 3D-modelled. The thought was for the pieces to be puzzled together as seen in figure 43, but when the L-insert has a draft angle, it can not be pressed down to the bottom as it is too wide. See figure 44. As the L-insert should be rather tight fitting to the outer part to prevent a flow of water from the side of the reservoir into the soil, the design cannot be shrunk to fit for the purpose of transportation.

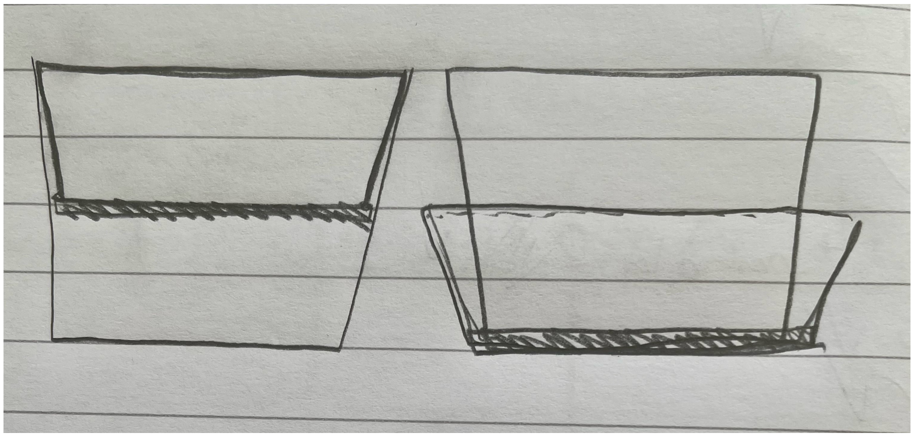

Figure 44: *Exaggerated simple sketch of disproportion of L-insert.*

Trying to find solutions while tweaking in SolidWorks, at first only more problems were discovered instead. It became apparent that no thought had been put into how the L-insert would even be fastened to its intended position, and having it be a permanent fixture was thought to ruin all chances of stacking. A ledge was designed for the L-insert to rest upon. And then came the idea of breaking the L-insert into two; L-bottom and L-top.

When PS FEJÖ is transported, all lose parts are packed in a cardboard box that fits perfectly in the area between the stacked outer pots, which is what inspired much of the rest of the development of this project. Tests were done in SolidWorks to see how the outer part would stack depending on both drafting and what draining was used. The tests showed how the height of the down draining affected how tightly the products could be stacked. Since the need of less frequent watering is of high customer importance, this was one of the reasons why this draining technique was not chosen for the final concept. Moreover, increasing draft led to decrease in spacing between stacked products, but as to not become unnecessarily large, the draft angle was decided then set to a value which balanced the two. The figure below shows how with the chosen draft angle, one could fit 11 down-drain solutions and 12 side-drain ones in the allowed height on a pallet.

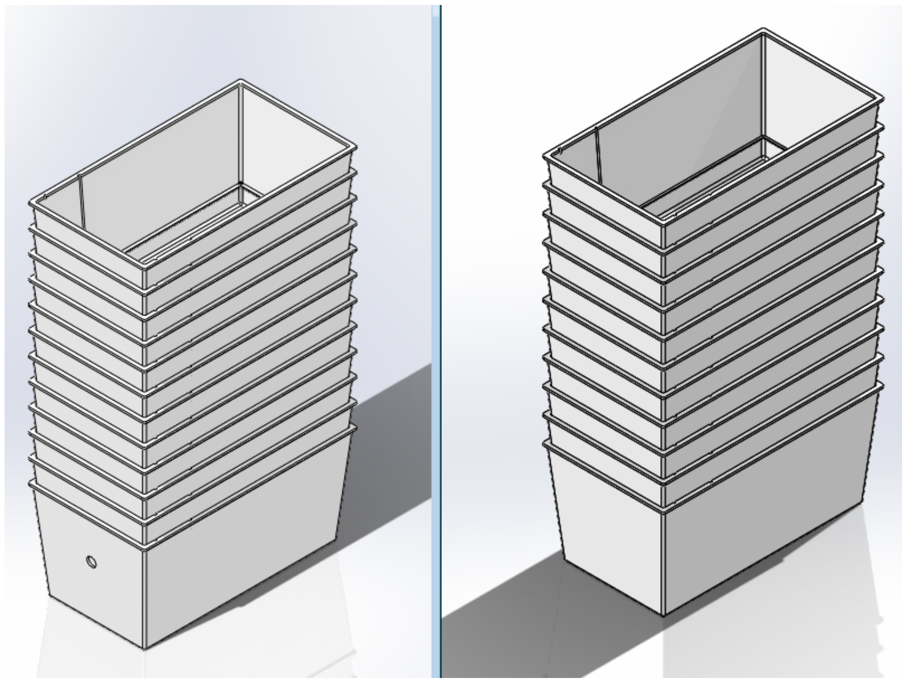

Figure 45: *Comparison of stacking the products with different draining placements, side-drain to the left and down-drain to the right.*

5.4 Manufacturing

Continuing, some of the final design choices regarded manufacturing methods. At first, when it was apparent L-bottom would not interfere with stacking in its intended position, two choices were on the table. The first was making it a permanent part of the outer part. However, this would make the most complicated component of the product even harder to manufacture. Tooling cost for injection moulded parts is highly dependent on the complexity of the part and was therefore deemed unnecessary. This is another reason why the concept with side draining was preferred. The second choice was if to go back to the bottom form from early stages of the concept, like figure 42. For the sake of simplicity, L-bottom stayed flat so that to avoid creating another tool for injection moulding. An idea to keep the manufacturing simple and cost effective was to design the rest of the parts completely flat: any additional quirk or modification for function would need to work around this by adding complexity to the outer part.

Two more problems needed to be solved. First of all, L-top would need to be more secured into the assembly. Only being able to modify it in 2D, a channel for sliding the part in place was added to the outer part and L-top was slightly widened. For the last problem, the lid still needed to be designed. With earlier decisions in mind, the lid did not need to have an abundance of rain collecting holes. It was instead designed to have a larger hole for easy watering and simply rest in its place using the channel for L-top, L-top as well as a smaller channel added to the moulded part. Finally, the mentioned design choices resulted in all inner parts to be fit for laser-cutting or some other cutting technique, which does not require special tooling based on part geometry.

5.5 Simulation test

Finally, before closing the development part of the project, some simple FEA-tests were performed using SolidWorks Simulations. Static tests with an estimated force from soil-, plant- and waterweight were conducted to analyse displacement and possible rupture due to stress concentrations. The early results showed that some modifications were needed or else displacement and sliding that appeared would be unnatural. This finally resulted in the final concept that will be presented in the next chapter.

6 Results

The following section features the final concept, both the 3D model and the physical prototypes, as well as the results from the FEA-simulation. Manufacturing suggestion and a simplified version of the packaging draft can also be found in this chapter. The assembly draft and the drawings are left out entirely due to confidentiality.

6.1 Final concept

The final concept consists of four necessary parts and one optional, that is outer part, L-bottom, L-top, a lid and finally the optional plug for the drainage hole. The goal of this project was to develop two concept options for the self watering solution, and so the other option is simply to add a wicking string to the planter. A wicking string can be beneficial for this product as the water level does not need to be as high, but it works fine without. This solution has not been modelled and will not be presented further.

6.1.1 3D-model

Figure 46 and 47 below show the final concept modelled in SolidWorks.

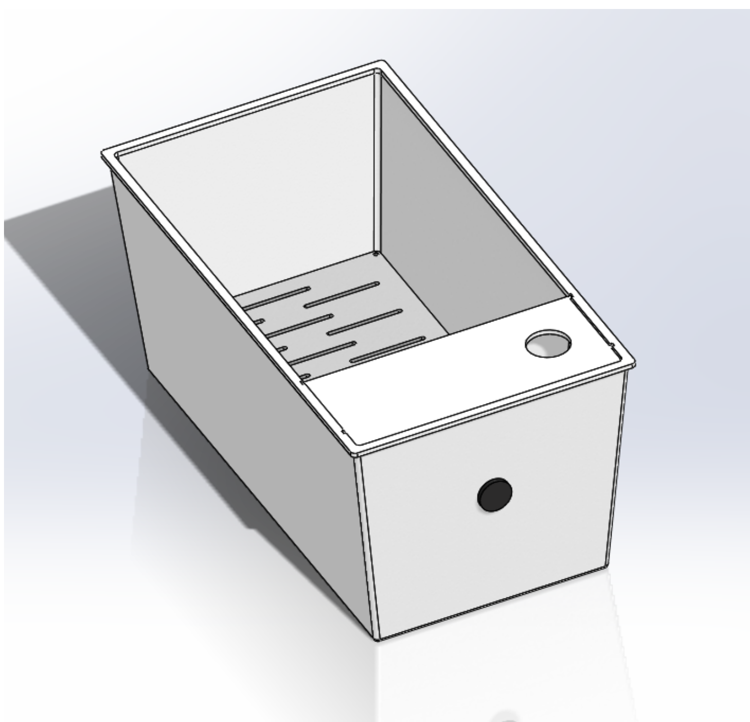

Figure 46: *3D-model of final concept, including plug.*

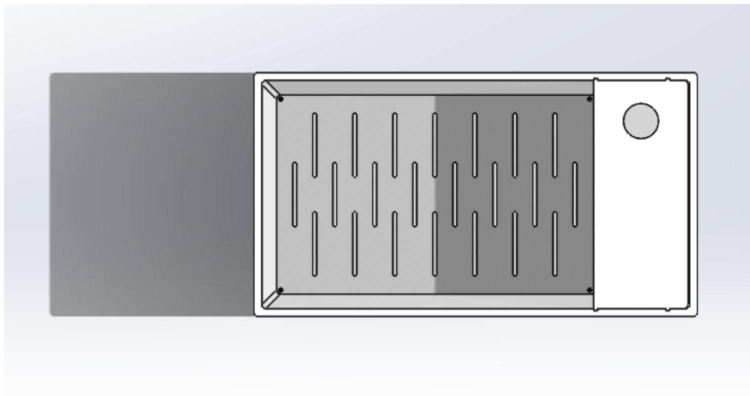

Figure 47: *Final concept viewed from above.*

A simple nursery pot, figure 48, was also modelled and scaled differently to show how many could fit in the planter. For the system to work without repotting, the nursery pots should have rather flat bottom area. Figures 49 to 51 show how some differently sized pots fit in the model. Worth mentioning that for figure 51, realistically due to nursery pots being very flexible a fifth pot could definitively fit, the fifth pot in SolidWorks only collided by a few millimeters and was therefore excluded from the figure.

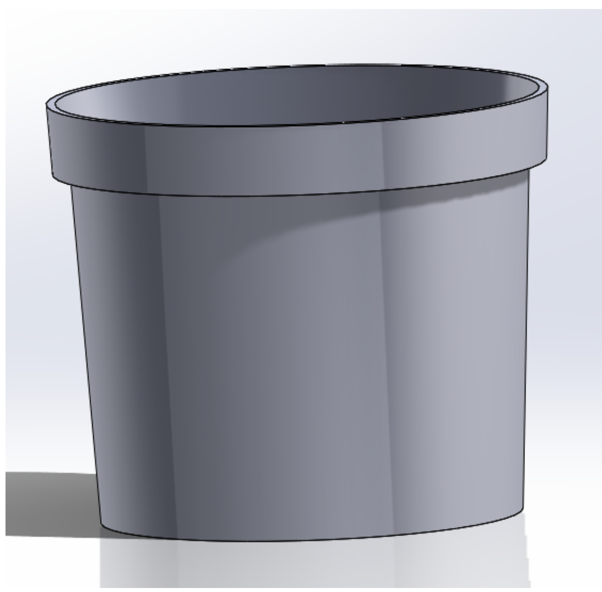

Figure 48: *Simple nursery pot model.*

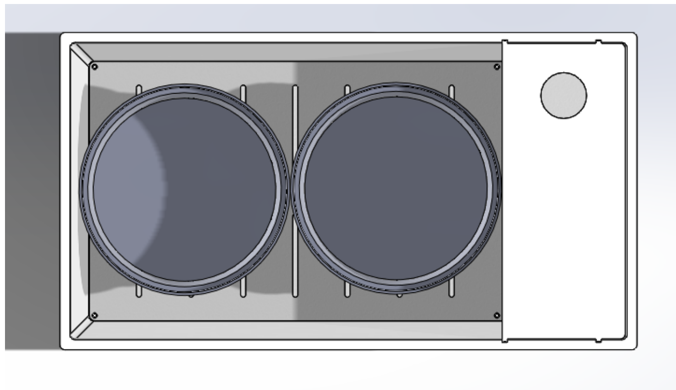

Figure 49: *Two ⌀18cm pots inside the planter.*

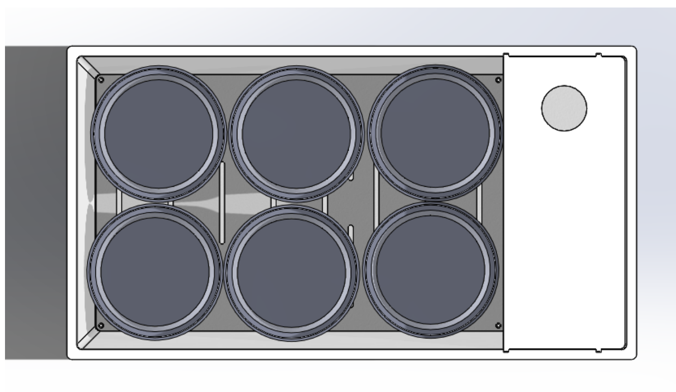

Figure 50: *Six ⌀11cm pots inside the planter.*

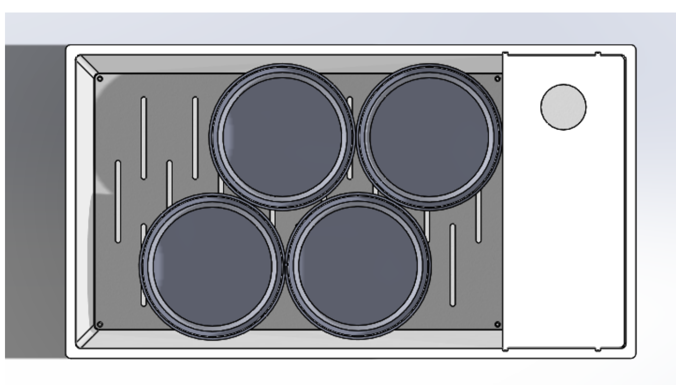

Figure 51: *Four ⌀12cm pots inside the planter.*

6.1.2 Physical prototypes

The first physical prototype was made in the prototype lab at IKEA of Sweden using cardboard scraps and a glue gun. Due to the one condition of using the lab being that no machines were to be touched without passing a special course, the parts were cut using primitive methods such as with scissors and knife. No regards to thickness was done for this prototyping which led to some improvisation. The purpose of this prototype was mostly sizing and is shown in figures 52 and 53.

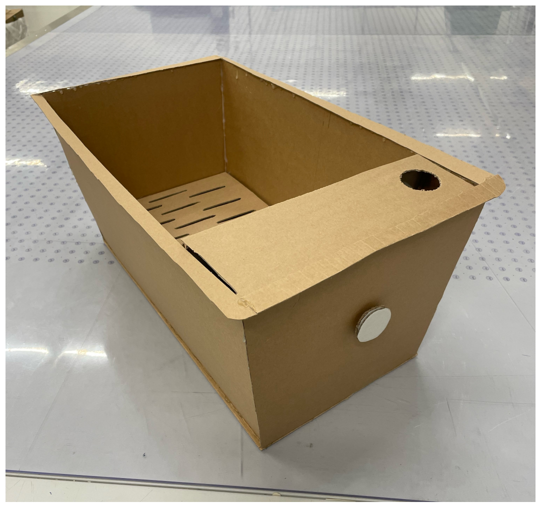

Figure 52: *Physical prototype of final concept.*

Figure 53: *Cardboard prototype seen from above.*

A 3D-print in a smaller scale was also ordered in the prototype lab. This model was used to verify the assembly and can be seen in figure 54 below.

Figure 54: *3D-printed prototype.*

6.2 Simulation of final concept

The following figures, 55 and 56, show the displacement and von Mises equivalent stress distribution of the final concept. The displacement was highest in the middle region of L-bottom at about 1.5mm. Furthermore, the highest equivalent stress reached a value of about 11MPa. If assuming the yield strength of recycled PP plastic of being around 16MPa, this is an acceptable value. Also, the forces used in the analysis for the soil and plant weight are exaggerated for margin reasons.

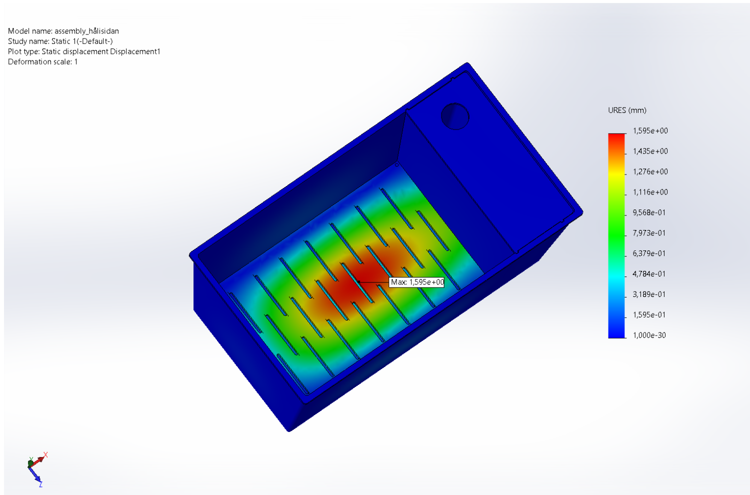

Figure 55: *Displacement analysis results.*

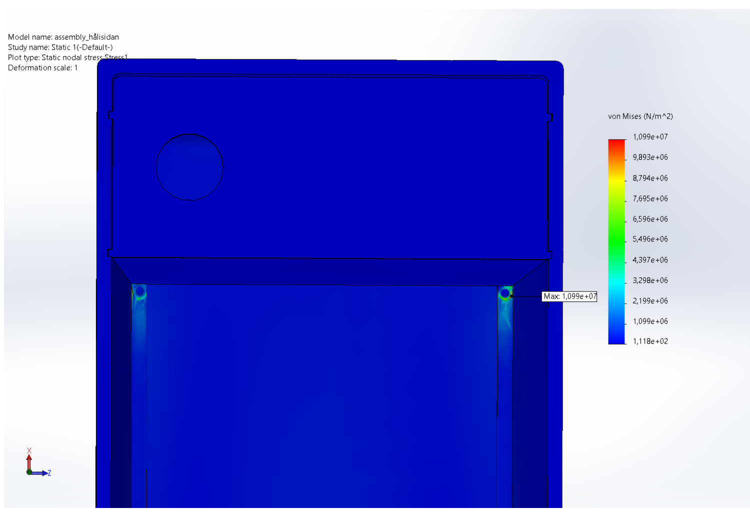

Figure 56: *Von Mises equivalent stress distribution.*

6.3 Manufacturing suggestion

As mentioned earlier during the development, a suggestion for the manufacturing would be to use injection moulding for the outer base and some precision cutting method for the rest of the product, such as laser- or water cutting. The plug could also be moulded, yet another suggestion might be looking into the existing range to find comparable products in the running range and from there adjust the size of the water outlet hole.

6.4 Packaging draft

The stacking of the final concept has already been presented in section 5.3. For the internal parts not to move around during transport a packing insert made out of cardboard can be added. Additionally, in order to avoid scratching between the parts, for example some thin paper sheets can be used for separation. Using a solution like this requires far less material than if the inner parts were all wrapped in a package. As can be seen in figure 57 below, 48 planters can be transported together on a pallet with some margin.

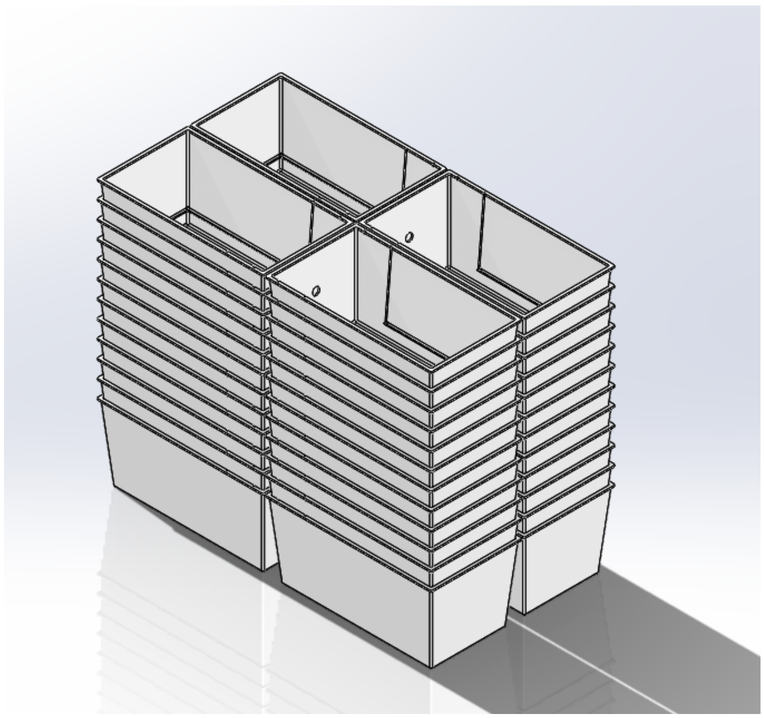

Figure 57: *Demonstration of potential pallet transportation solution.*

7 Discussion

Before concluding this project, the following discussion reflects on different topics related to both the execution and results of the thesis.

7.1 Theory reflection

Though the intention before starting was to follow Ulrich and Eppingers concept development process, this proved to be difficult due to the span and delimitations of the project. Another reason was how the project was affected by IKEAs own development process that was mentioned briefly in section 2.3. For instance it was decided together with supervisors at IKEA that the project would mostly follow the activities covering approximately the first half of their development process. However, this proved to be difficult in other ways as the implementation of this method is not designed to be performed individually. To clarify, there are certain specialized roles for many of the parts in the process, and to accurately perform these alone would be nearly impossible.

Instead, a combination of both methods was performed in order to complete the project. From *Product Design and Development*, some selected activities were chosen and the adjusted method can be seen either in figure 58 or by reading chapters 3 through 5 for how they were applied.

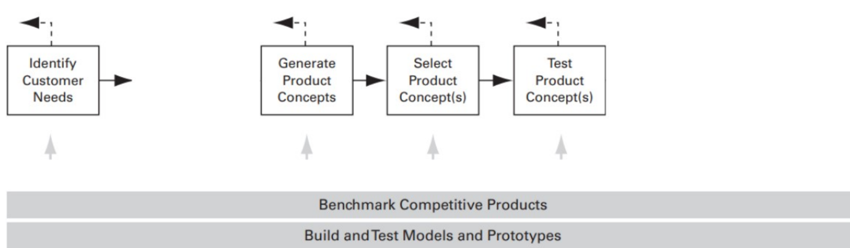

Figure 58: *Adjusted version of the Ulrich and Eppinger concept development.*

Without going into too much detail, the majority of the excluded activities either did not have any corresponding counterparts, were too dependent on other people or external factors, or are usually performed in later stages of the IKEA development process. But for instance excluding the economic analysis had more to do with irrelevancy for the project and its deliverables.

7.2 Project results

Despite everything, the solution proved to be a fully functional solution with no apparent need for a decorative outer planter. Further work could be done to improve the overall aesthetic of the solution to make it fit for direct use. For instance, though functional, the water draining from the side was not meant to be seen directly by users and was supposed to be hidden by the additional planter. Nevertheless, the construction is still simple enough for it to work as an insert as well. It could perhaps also be an idea to adjust the dimensions of the planter so that it could be an attractive solution for different types of homes with varying outdoor space.

The side draining has been placed at an arbitrary height and could be changed depending on need. For instance, tests might prove that the water reservoir would need to have a higher capacity, and in this case the hole can just be placed higher.

Though it is optional for the concept, the plug enabling indoor use broadens the market use for the product. Additionally, during very dry seasons with no rain, thanks to the plug, the water reservoir can store even more water which helps the customer to keep their plants healthy without the need of daily watering. Again, this feature leads to the product reaching more markets, as places with constant high temperatures might only benefit from storing abundant amounts of water.

For the sake of simplicity, no water level indicator was developed for the product. But it could be a simple idea to use the supplier of PS FEJÖs indicator to manufacture a similar tube. Moreover, perhaps a more hidden version of the watering hole could be developed. This is due to the product being for outdoor use, and leafs among other things could fall in on accident causing the product to malfunction.

On a final note regarding options for the planter, the second solution using string was not presented mostly due to time constraints. Also, it does not change too much about the final concept and more presentation was therefore deemed unnecessary. Something to think about if string were to be used is for it to be of synthetic materials so it does not lead to root rot, as many organic string materials would not handle the constant humidity well and easily mold. This would lead to the string and soil needing to be replaced frequently, which is not a user friendly nor sustainable approach.

7.3 Challenges

Before getting properly started with the project, despite timeplanning, supervision and help from the development team, it was hard to grasp the extent of what was expected from the results. Though many product development projects had been performed during classes at the university, some even in collaboration with real companies, this was completely different as it constantly felt more real. After some time, it was realized that it was in fact very similar to the earlier experiences once everything was broken down into subproblems. Much of the overwhelm came from wanting to work in the exact same way that the other product developers did, without first realising that the expected outcome was never the same. Nobody expected the thesis project to deliver a sales ready product in a timespan much shorter than what is usually given to entire PD groups. This challenge was therefore conquered by distancing the Master Thesis project from the development project, without ever letting the two lose connection.

Though everyone has been extremely helpful for the project, the shifted timeplans between the PD team and the thesis project led to unnecessary complications. The projects starting at different times, and even more so that this was not clear from the beginning, led to much confusion. This challenge was overcome using much communication and flexibility.

In retrospect, one of the greatest challenges of this project was staying within the set boundaries. It was set from the beginning that the task revolved mainly around the self watering mechanism, and even though one could argue that this implies the design of the entire pot, this actually is not the case. Furthermore, it was easy to fall into looking at solutions for sectioning, especially solutions where the structure is connected in a significant way, see concepts A and B in figures 22 and 23 respectively. This challenge has proved even further that product development simply is not a linear process, especially if a project consists of more than one single product and even more so if these are interdependent in any way. In the end, the final concept could be potentially used as either a planter or an insert. Fortunately, in a real product developing environment, one can probably branch out more freely between dependent products as the different constraints are most likely more coordinated.

7.4 Improvement areas

As can be seen in Appendix A, the preliminary time plan does certainly not align with the actual timeline of the activities during the project. The first timeline got the end time of many activities right, their duration and overlap on the other hand was rather off. A rather naive assumption when making the preliminary plan was that the activity of "Getting to know the company" only would last for the first six weeks. With such a large, global company, it should not have come as a surprise that far from everything was known the first six weeks, let alone at the end of the project. It should be noted that one of the only reasonable parts of the preliminary plan was how an alarming amount of activities overlapped during the final weeks. In retrospect it is also noted how building physical prototypes was forgotten to be put in the plan, but since this activity did not take up much real time, it was not far from the truth.

It is of no doubt that the research for customer inputs and needs could have benefited from an extensive group of people being interviewed or alike. Especially since the product can be potentially sold all over the world, asking customers at least living in different climates could have been quite useful. A thorough observation of customer interactions could have also been of interest, unfortunately the research was done in the middle of winter in Sweden, leaving little greenery, planters and people to observe.

Something that would be changed if the project was to start over is definitely to create more physical prototypes. It was first deemed unnecessary as a CAD-model requires less time and material. But a combination of both methods for concept selection could perhaps have led to other creative solutions or maybe discovering certain problems earlier.

7.5 Further development

To continue the development for the self watering insert, the first step would be to create more prototypes. These would then go through several tests, both testing functionality but also perhaps something in the line of co-creation to get the opinion from as many customers as possible. It should for instance be tested whether the placement and size of the holes in L-bottom are fit for the purpose, and this could probably first be tested with some CFD analysis (Computational Fluid Dynamics) before testing physical prototypes. Other aspects regarding dimensions should be revised by performing some structural optimization analysis and getting rid of unnecessary material by perhaps altering wall thickness. Thorough manufacturing instructions, including tooling design as well as drawings with tolerances should be developed. Hopefully, a supplier which delivers both moulded and cut plastic parts can be contacted to receive some real samples that can be used for further testing and validation.

Although the material is set to be plastic with high recycled content, for further development other materials should be looked into. This due to plastic not being an optimal option from a sustainability point of view. Also, since the use of recycled plastics is relatively new, the quality and durability can unfortunately not be guaranteed. For further development it could be possible to research the use of new, innovative materials such as spill or waste from the food industry for example coconut husks or alike.

8 Conclusion

The development of the self watering planter has resulted in a promising product concept. It has been developed using the Democratic Design principles, overall fulfills the customer needs in a satisfying manner and is suitable for an outdoor product, all while having the circularity goals in mind. The project deliverables have been accomplished in reasonable ways, providing not only with assembly, drawing and packaging drafts, but also with suggestions for manufacturing. Though more prototypes could have been built as well as perhaps testing of the function, the time was unfortunately insufficient. Nevertheless, even with more time, the simple prototypes and tests that could have been done in the span of this project would not have reached the quality needed for IKEA standards anyway. In conclusion, the self watering planter should continue to be developed by IKEA and can hopefully be a part of the range one day.

References

[1] Monica Hemingway - Gardening Products Review . *All About Self-Watering Planters & Containers*. URL: https://gardeningproductsreview.com/all-about-self-watering-planters-containers/. (accessed: 24.02.2023).

[2] Amazon. *RAINPOINT WiFi Automatic Watering System For Indoor Potted Plants, DIY Drip Irrigation Kit Remotely Control Auto/Manual/Delay Watering Mode via APP, Automatic Self-Watering Irrigation System with Pump*. URL: https://www.amazon.com/RAINPOINT-Automatic-Watering-Irrigation-Self-Watering/dp/B09GYDBC7Y. (accessed: 01.03.2023).

[3] Succulent plant care. *Choosing the Right Pot for Succulents: Pros and Cons*. URL: https://succulentplantcare.com/choosing-the-right-pot-or-container-for-succulents/. (accessed: 27.03.2023).

[4] Living Color Garden Center. *Should You Use A Self-Watering Pot?* URL: https://livingcolorgardencenter.net/gardening/using-self-watering-pots/. (accessed: 26.02.2023).

[5] PM Study Circle. *Design for X*. URL: https://pmstudycircle.com/design-for-x-dfx/. (accessed: 10.02.2023).

[6] How to Culinary Herb Garden. *8 Automatic Plant Watering Systems To Make Herb Gardening Easier*. URL: https://howtoculinaryherbgarden.com/automatic-plant-watering-systems/. (accessed: 26.02.2023).

[7] Elho. *GREEN BASICS VEGGIE WALL 80CM LIVING BLACK*. URL: https://www.elho.com/se/produkter/green-basics-veggie-wall/green-basics-veggie-wall-80cm-living-black/. (accessed: 01.03.2023).

[8] Elho. *GREENSENSE AQUA CARE ROUND 30CM LIGHT CONCRETE*. URL: https://www.elho.com/se/produkter/greensense-aqua-care-round/greensense-aqua-care-round-30cm-light-concrete/?scroll=404. (accessed: 01.03.2023).

[9] Elho. *SELF-WATERING INSERT 17CM LIVING BLACK*. URL: https://www.elho.com/se/produkter/self-watering-insert/self-watering-insert-17cm-living-black/. (accessed: 01.03.2023).

[10] Willab Garden. *GoGro krukor 2 stk*. URL: https://www.willabgarden.se/produkter/tradgard/bevattning/sjalvbevattnande-krukor/gogro-krukor-2-stk/. (accessed: 01.03.2023).

[11] Joe Gardener. *054-Plastic Nursery Pots – Greening Up The Darkest Side of Gardening*. URL: https://joegardener.com/podcast/plastic-nursery-pot-recycling/. (accessed: 26.02.2023).

[12] Epic Gardening. *Which Plastics Are Safe For Gardening?* URL: https://www.epicgardening.com/which-plastics-are-safe-for-gardening/. (accessed: 27.03.2023).

[13] Grow a Good Life. *Build Your Own Self Watering Containers*. URL: https://growagoodlife.com/constructing-18-gal-self-watering-containers-swc/. (accessed: 26.02.2023).

[14] Hornbach. *Självvattnande blomkruka LECHUZA Deltini Ø14x18cm antracit*. URL: https://www.hornbach.se/p/sjalvvattnande-blomkruka-lechuza-deltini-o14x18cm-antracit/8867222/. (accessed: 01.03.2023).

[15] IKEA. *1998 IKEA catalogue*. URL: https://ikeamuseum.com/en/digital/ikea-catalogues-through-the-ages/1990s-ikea-catalogues/1998-ikea-catalogue/. (accessed: 28.02.2023).

[16] IKEA. *2003 IKEA catalogue*. URL: https://ikeamuseum.com/en/digital/ikea-catalogues-through-the-ages/2000s-ikea-catalogues/2003-ikea-catalogue/. (accessed: 28.02.2023).

[17] IKEA. *2010 IKEA catalogue*. URL: https://ikeamuseum.com/en/digital/ikea-catalogues-through-the-ages/2010s-ikea-catalogues/2010-ikea-catalogue/. (accessed: 01.03.2023).

[18] IKEA. *2013 IKEA catalogue*. URL: https://ikeamuseum.com/en/digital/ikea-catalogues-through-the-ages/2010s-ikea-catalogues/2013-ikea-catalogue/. (accessed: 01.03.2023).

[19] IKEA. *2015 IKEA catalogue*. URL: https://ikeamuseum.com/en/digital/ikea-catalogues-through-the-ages/2010s-ikea-catalogues/2015-ikea-catalogue/. (accessed: 01.03.2023).

[20] IKEA. *2016 IKEA catalogue*. URL: https://ikeamuseum.com/en/digital/ikea-catalogues-through-the-ages/2010s-ikea-catalogues/2016-ikea-catalogue/. (accessed: 01.03.2023).

[21] IKEA. *CIRCULAR PRODUCT DESIGN GUIDE, Guide to Navigating Through the Process of Designing Circular Products*. URL: https://gbl-sc9u2-prd-cdn.azureedge.net/-/media/aboutikea/newsroom/documents/512088_v2.pdf?rev=cd1d03b6b74c4544b1705c7a73df31f2&hash=%5C%5C%2049420E99AFDD82C3F7C6BC0CB52AFD8B. (accessed: 24.02.2023).

[22] IKEA. *Co-creation – working with you to develop better products for life at home*. URL: https://about.ikea.com/en/life-at-home/co-creation. (accessed: 27.02.2023).

[23] IKEA. *Democratic Design - Make things better by making better things*. URL: https://about.ikea.com/en/newsroom/2019/06/04/democratic-design--make-things-better-by-making-better-things. (accessed: 24.02.2023).

[24] IKEA. *Democratic Design. Making great design available to everyone.* URL: https://about.ikea.com/en/life-at-home/how-we-work/democratic-design. (accessed: 23.02.2023).

[25] IKEA. *IKEA PS FEJÖ*. URL: https://www.ikea.com/se/sv/p/ikea-ps-fejoe-sjaelvbevattningskruka-vit-20039394/. (accessed: 28.02.2023).

[26] IKEA. *Marcus Engman to talk at What Design Can Do*. URL: https://about.ikea.com/en/newsroom/2017/05/22/marcus-engman-to-talk-at-what-design-can-do. (accessed: 23.02.2023).

[27] IKEA. *Milestones of IKEA*. URL: https://about.ikea.com/en/about-us/history-of-ikea/milestones-of-ikea. (accessed: 09.02.2023).

[28] IKEA. *The story of IKEA flatpacks*. URL: https://www.ikea.com/ph/en/this-is-ikea/about-us/the-story-of-ikea-flatpacks-puba710ccb0. (accessed: 08.03.2023).

[29] IKEA. *Utekrukor, blomlådor & spaljéer*. URL: https://www.ikea.com/se/sv/cat/utekrukor-blomlador-spaljeer-30436/. (accessed: 26.02.2023).

[30] Inter IKEA. *IKEA culture and values*. URL: https://www.inter.ikea.com/en/how-we-do-business/ikea-culture-and-values. (accessed: 23.02.2023).

[31] Steven D. Eppinger Karl T. Ulrich. *Product Design and Development - Sixth Edition*. McGraw-Hill Education, 2016. ISBN: 978-0-07-802906-6.

[32] Verticale Tuin Maken. *Minigarden Basic S*. URL: https://verticale-tuin-maken.nl/en/product/minigarden-basic-s-en/. (accessed: 01.03.2023).

[33] Nola. *Säby Planteringskärl*. URL: https://nola.se/produkter/saby/. (accessed: 01.03.2023).

[34] Nola. *Sturup Planteringskärl*. URL: https://nola.se/produkter/sturup/. (accessed: 01.03.2023).

[35] Pistils Nursery. *How to Plant in a Pot Without Drainage Holes*. URL: https://pistilsnursery.com/blogs/journal/how-to-plant-in-a-pot-without-drainage-holes. (accessed: 26.02.2023).

[36] Patch. *Everything you need to know about plant pots*. URL: https://www.patchplants.com/gb/en/pots-need-to-know/. (accessed: 26.02.2023).

[37] Plantagen. *Bevattningsset till vertikal växthållare Gardena NatureUpp*. URL: https://www.plantagen.se/bevattningsset-till-vertikal-vaxthallare-gardena-natureup-525445.html. (accessed: 01.03.2023).

[38] ProductPlan. *What is Product Development?* URL: https://www.productplan.com/learn/what-is-product-development/. (accessed: 22.02.2023).

[39] Ruthanne Hanlon - Swatchbox. *The Growth of Biophilic Design in a Post-Pandemic Society*. URL: https://www.swatchbox.com/blog/The-Growth-of-Biophilic-Design-in-a-Post-Pandemic-Society. (accessed: 22.02.2023).

[40] Wikipedia. *Capillary action*. URL: https://en.wikipedia.org/wiki/Capillary_action. (accessed: 18.01.2023).

A Appendix A

The figure below shows the preliminary timeplan of the project followed by the real timeplan of how the activities were performed in the end.

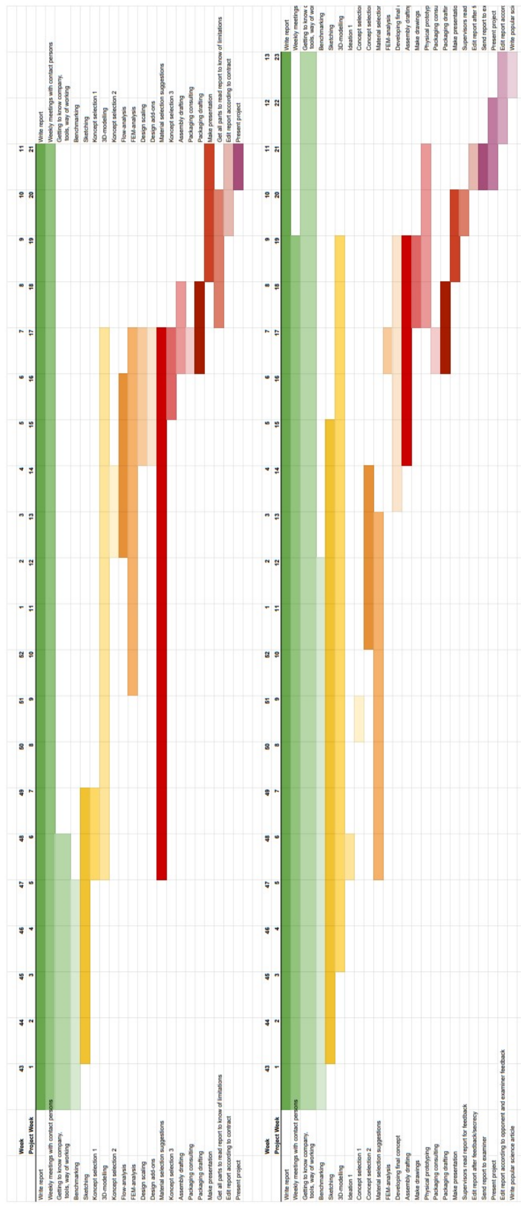

Figure 59: *Timeplan of the project.*