Square One

Smart Hydroponic Systems

A VISION FOR HOMEGROWN FOOD

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Graduation Design Portfolio

2020

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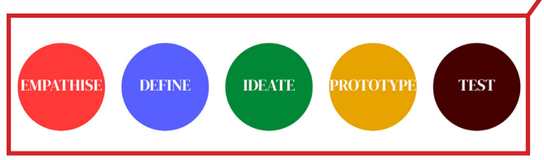
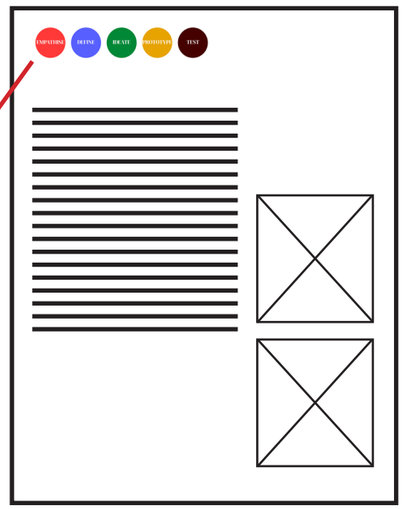
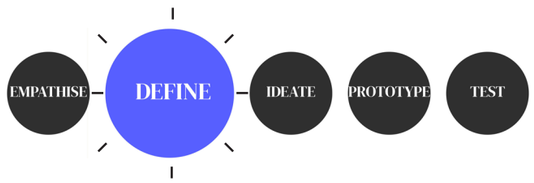
CONTENTS

The Stanford’s ‘Design Thinking Process’ diagram will be evident in the top left corner for most of the pages of the project. The diagram will guide the readers to understand and connect a certain stage of the project with a phase on the Design Thinking Process.







The current design stage of the project will be visually connected and displayed with a phase of the Design Thinking Process.

With the help of the diagram, the content will communicate the decision making better and more efficiently providing an understanding of the overall picture.

DESIGNING THE FUTURE

The essence of this final university project will aim to target issues which are results of human action or part of connected chain-like actions based on human activity.

The project will explore in-depth the changing food production practices worldwide followed by a reflection and analysis of the impact on other sectors affected in the process.

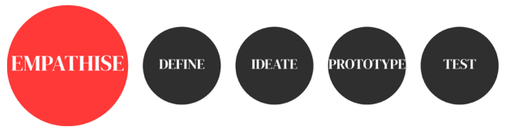
A design brief will then set guidelines for a constructive development of a product solution based on several stages of literature reviews, first-hand observational research, online research, evaluation, testing, constriction of prototypes, conduction of interviews, site visits, and more.

The project’s documentation will also touch areas which in one way or another will affect the outcome of the project such as efficiency, usability, technology, finance, and psychological impact.

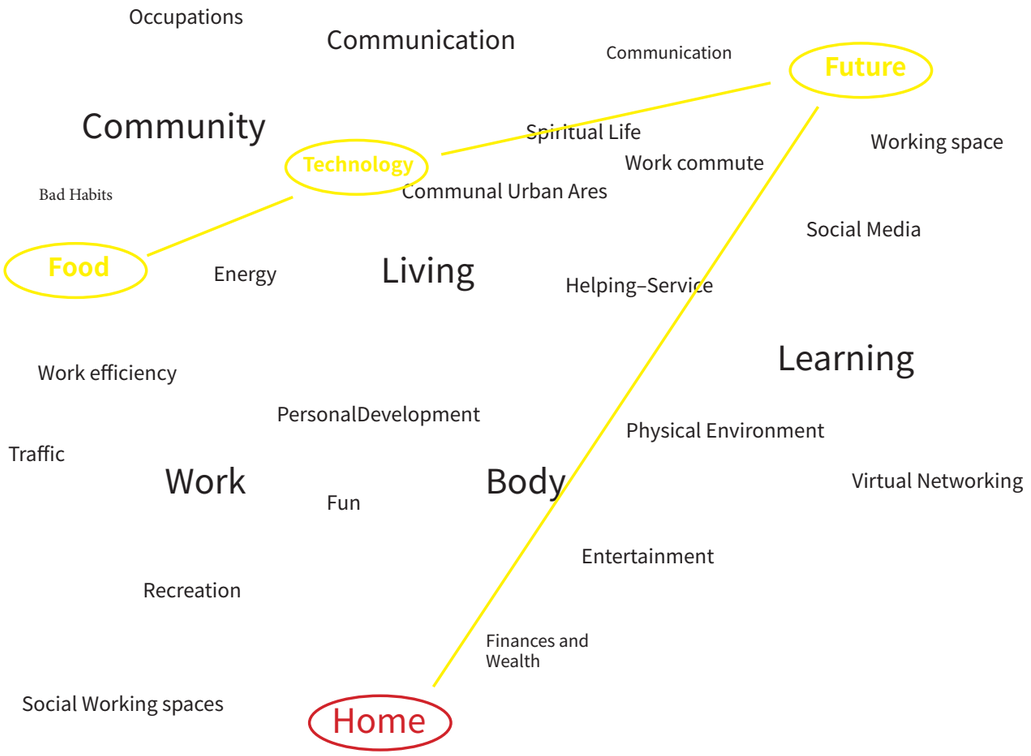
Due to circumstances from the COVID-19 pandemic of early 2020, access to university facilities and technical support have affected to an extent the final outcome of the project.

The project began with a broad exploration of identifying opportunistic areas that could be improved and further advanced. Some general areas and specific potential topics were laid down which in recent years have been heavily discussed and have been a focus for a lot of people and organisations emphasising on the need for reconsideration of the whole concept behind the currently established ones.

Areas such as transportation, energy production, and virtual networking are now being conceptualised for the very near future in a much different way from what the world has currently adopted. With globalisation international companies, tech giants, and even governments and able to work together in order to acknowledge the fast-changing lifestyle and demand of the everyday person. To accommodate this ever-changing style of living fundamental actions of the production and supply structure must be taken, sooner or later.



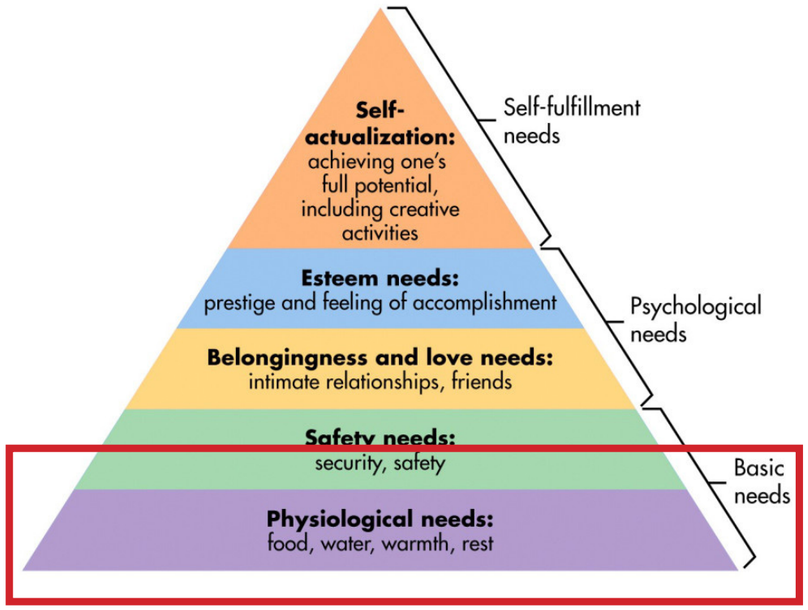
After exploring several of these new trends and their potential I decided to focus on a topic standing on the bottom of the hierarchy of needs. Therefore, addressing the focal point as a design guide for basic human needs such as food, rest, warmth, etc.



EMPATHISE DEFINE IDEATE PROTOTYPE TEST

The Maslow's Hierarchy of Needs is a motivational theory depicting five hierarchy levels of human needs positioned in a chronological uprising order of meaning and importance of one's stage of life. The theory of looking into the peoples' motivational behavior and how their actions are driven by deficiencies of certain needs in their lives.

It is often speculated that the theory is illustrating a perfect progression of a person's life following each step into a fulfillment. However, Maslow himself refuted these interpretations clarifying the theory is only following the actions of an individual which ultimately completes a certain need, which then triggers a desire for progression. These stages do not have to be necessarily met at 100% in order to develop further.



Img. 1 Maslow's hierarchy of needs

CURRENT ACTIVITIES AFFECTING THE FOOD PRODUCTION

The Following Pages will summarise literature reviews and broad research of well recognised sources of data gathered from NGOs and organisations such as - The World health organisation, United Nations, The World Bank, The World Resource Institute ...etc. This section of the project will also introduce the major factors of the current state of the worlds' agriculture policies and their impact on the people, wildlife, and the environment.

The data provided will support the project on almost every aspect in terms of development, functionality, usability, and human involvement.

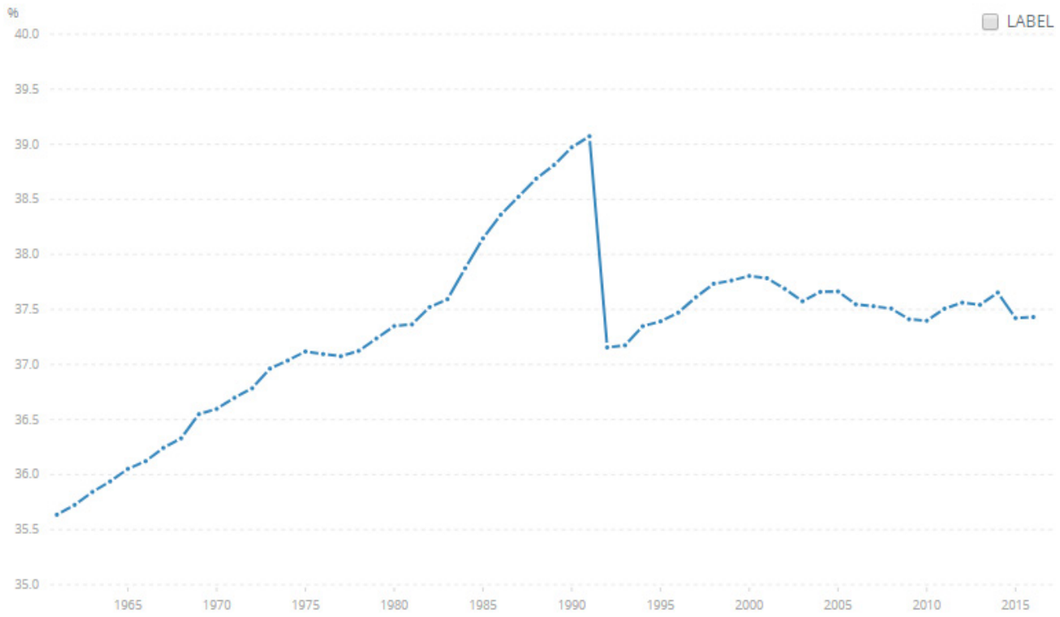
At the end of this section, one can see the projects' defined aim and reasoning as well as the suggested proposal and resolution of the topic.

37% OF THE ERATH'S LAND AREA IS USED FOR AGRICULTURE

The first issue concerning the agricultural process of crop and livestock farming is the huge amount of land used for agriculture. 37% of the Earth's land surface is used for conventional crop and livestock farming.

Scientists of the University of Wisconsin-Madison used satellites to assess the impact of agricultural land on the environment. The images of the satellites showed an area roughly the size of South Aerica being used for crop farming, while even more land is being used for livestock farming (National Geographic, 2005).

Graph 1. Agricultural Land as persentage of Earth's land area (WorldBank, 2015)



Sadly, forests and wild animal life are on the first row of those subdivisions being effected the harshest to the point of extinction of species and rainforests. Examples of deforestation for new crop production can be seen all over the world, perhaps most noticeable due to media coverage is the Amazon delta of forests being destroyed in order to open land for the creation of new crops.
"If current trends continue, we should expect to see increased agricultural production at the cost of increased tropical deforestation." (SAGE researcher Amato Evan for NG).

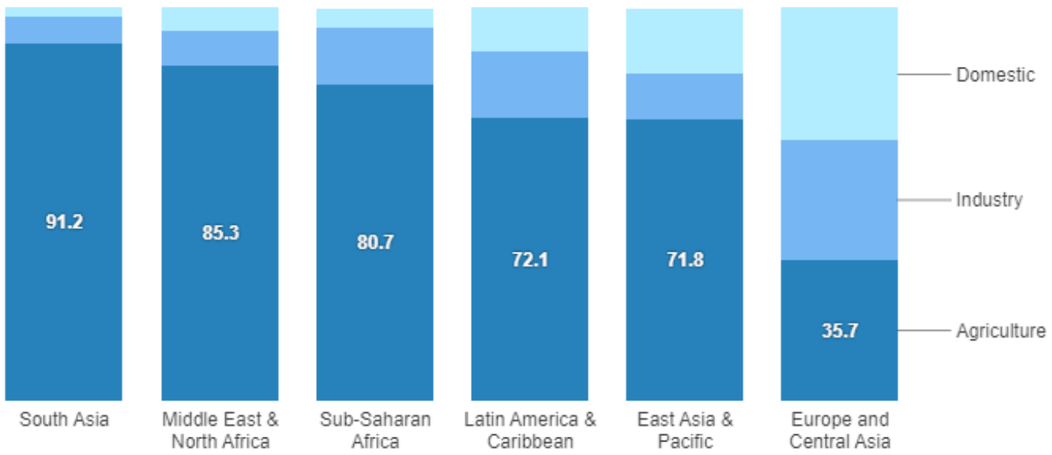
Img. 2

70% OF FRESHWATER IS USED FOR AGRICULTURE (World Bank)

This huge landmass used for agriculture requires an enormous amount of freshwater to supply the crops. According to the (World Bank, 2017) 70% of the world's drinkable water is used for agriculture. As a contrast only 2,5% of the Eath's water supply is freshwater, most of it stored in hard to access places such as show field and ice glaciers.

The graph below shows the distribution of freshwater in three major sectors around the world - Domestic use, Industrial use, and Agriculture. The efficient use of water according to the World Bank comes down to proper water management. The world's population is projected to reach nearly 10 billion people by 2050. Therefore, the demand for fiber-rich foods will increase as well as the demand for water in order to supply the crop-based foods.

Graph 2. Share of freshwater withdrawals by sector (%) in 2014 (WorldBank, 2014)



Adequate water management will be an essential structural measure when dealing with the facing huge commercial demand projected by many. Though, signs of established management practices through regulations are already put in place in some parts of Europe, North America, and Central Asia.

The current agricultural management lays mostly in the hands of governments, local authorities and very little is being decided on an international scope by global organisations. Although there have been some regulations of groundwater usage worldwide, lots of countries with rich water resources decide to neglect these regulations in a chase for higher production rates and profits.

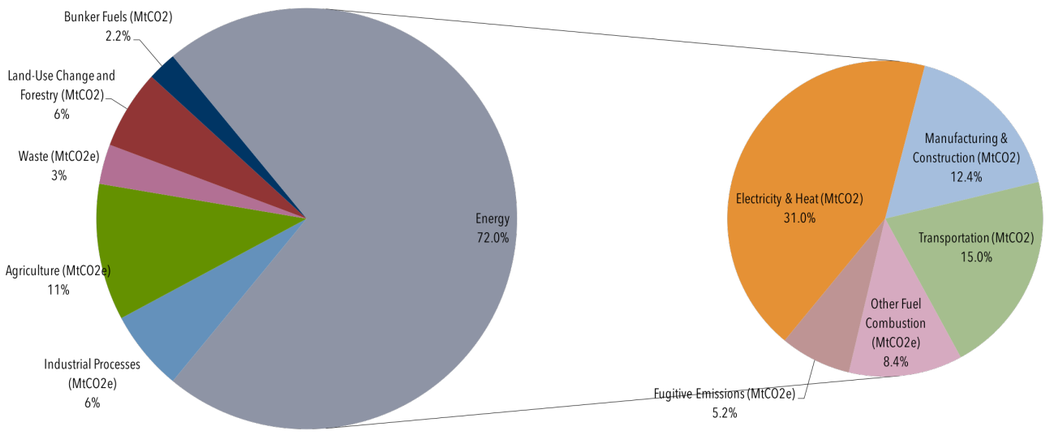
Img. 3

THE IMPACT OF THE AGRICULTURAL PROCESS

Agriculture is the second-largest sector by production of greenhouse gas emissions. Standing ahead of sectors like transportation and manufacturing. Which the majority of people see as the major contributors to global warming. While in fact, agriculture is far more damaging to the environment.

The info graph below shows the agricultural greenhouse gas emissions being compared to other extensive sectors.

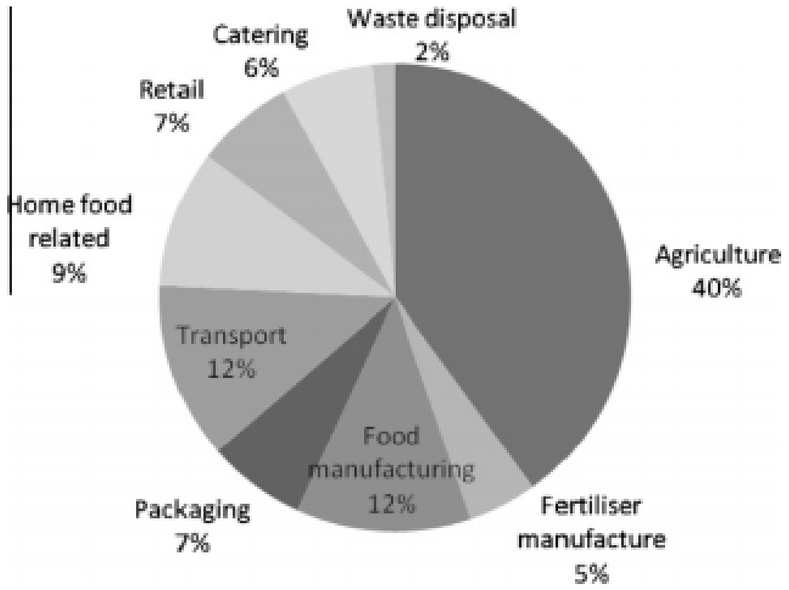
Graph 3. Global Manmade Greenhouse Gas Emissions by Sector, World Resources Institute, (2017)



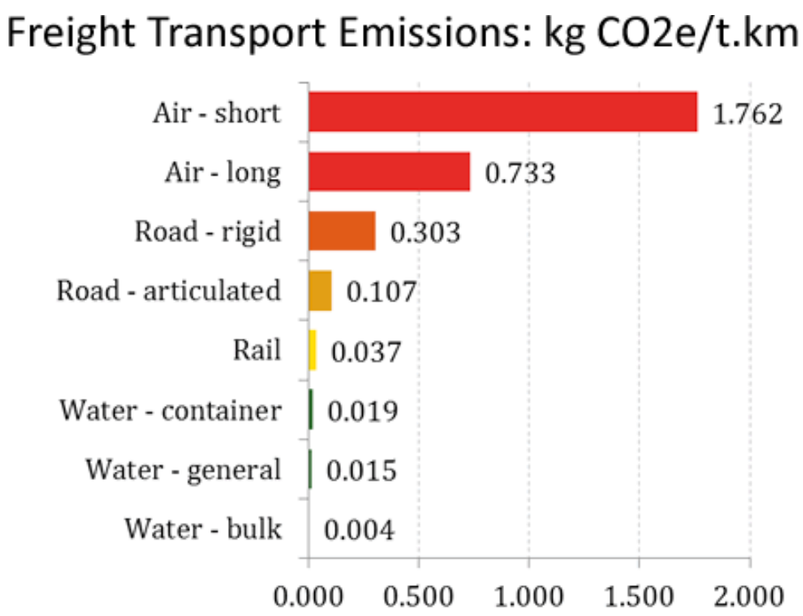
TRANSPORTATION OF FOOD AMOUNTS TO 12% OF THE GREENHOUSE GAS EMISSIONS PRODUCED IN THE FOOD CHAIN PROCESS

When one looks closer into the agricultural process as a whole, It is easy to identify the impact of just transporting the produced food to retailers and consumers.

The transportation of food produces just as much greenhouse gas emissions as the ‘Food manufacturing’. These striking statistics regarding food transport are even more prominent in countries with widespread road-based supply chains like the US, for example.



Graph 4.Breakdown of food chain GHG emissions in the UK excluding land-use change. Source: adapted from Garnett (2008).



Graph 5. Freight Trasport Emissions, (DEFRA, Emissions Factors)

A breakdown of the Co2 emissions emitted by the transport sector for food cargo shows the four general types of transporting food and their footprint- water, rail, road, and air.

Water transportation and ship cargo are predictably the most efficient method of transportation, due to the large space capacity of the shipping carriers and the convenience of carrying large quantities of goods in shipping containers.

Rail transportation, on the other hand, is also being suggested as a very efficient and quick method of transporting food. Some of the problems, however, of rail transportation are the development and maintenance of railroad infrastructure as it often comes as a large investment cost. On the bright side, companies such a 'Hyperloop One' are the pioneers of investment and development in a superfast rail transportation system for fast travel of people and goods between cities.

Air transportation is the least popular method for transporting food in the UK and it accounts for only 1% of all of the food transported, yet it produces 11% of the Co2 emissions emitted from all means of food transport.

Img. 4

1/3 OF THE FOOD WORLDWIDE IS BEING WASTED

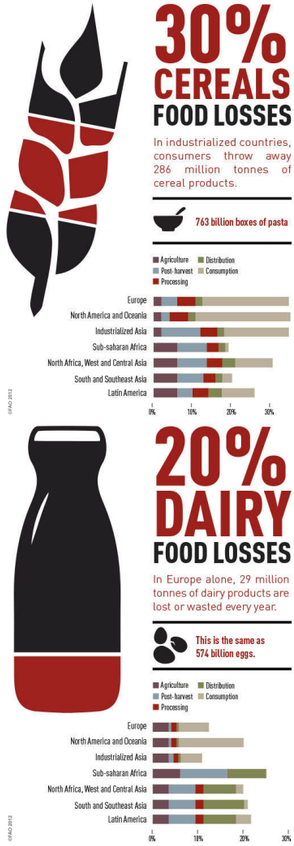
Roughly one-third of the food produced in the world for human consumption every year — approximately 1.3 billion tonnes — gets lost or wasted. (FAO). By 2050, the world will need 60% more calories per year in order to feed the projected 9 billion people.

While in the industrialised countries the food loss predominantly happens in the retail and consumer level, in the developing countries one can see the contrast of food loss is dominant in the early stages of the food production such as harvesting and storage. In developed countries, the cause of food waste and loss in the retail field is mostly due to poor coordination and logistics management in the supply chain. On the contrary, low-income countries face problems concerning food waste mainly caused by efficiency techniques, lack of equipment, financial investment, and storage facilities.

Land restoration and food waste were put as two of the 4 essential sectors by the World Resources Institute, which have the largest impact on the global GHG Emissions. And they are also 2 of the 4 factors that they clam should change first in order to prevent a global warming crisis.

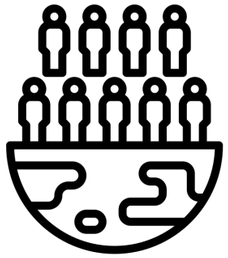
Img.5-8

Img.9-11



EMPATHISE DEFINE IDEATE PROTOTYPE TEST

BY 2050, 68% OF THE WORLD'S POPULATION WILL LIVE IN URBAN AREAS (United Nations, 2018)



The urban population is on the rise, more people move into cities every year in search of better lives, business opportunities, or and more convenient life. Regardless of the reasons why people decide to move into cities, the urban areas are transforming into large and very densely populated hubs. This global urbanisation makes the task of maintaining this hub consequently more difficult with time. Urban subdivisions such as internal transport networks, new construction sites, and standardised urban planning are beginning to challenge even the wealthiest and most developed cities around the world.

New alternatives suggest a reconsideration of how cities are designed and planned. The way cities are being supplied with resources is changing as for example, ways of transporting goods inside the city areas still quite inefficient.

In 2018, 1.7 billion people—23 percent of the world's population—lived in a city with at least 1 million inhabitants. In 2030, a projected 28 percent of people worldwide will be concentrated in cities with at least 1 million inhabitants. (United Nations, 2018)

Between 2018 and 2030, the urban population is projected to increase in all size classes, while the rural population is projected to decline slightly. Rural areas were home to 45 percent of the world's population in 2018, a proportion that is expected to fall to 40 percent by 2030. (United Nations, 2018).

Img. 12

HOW CAN DESIGN SOLVE A FUTURE FOOD CRISIS?

DESIGN BRIEF

Having laid down the evidence concerning the present and forthcoming condition of the agricultural process I set on defining goals for the design brief which will aim to influence and impact the summarised data of reports, articles, books, and literature reviews shown in the previous section.

The objective will propose finding a solution trough designing a device for the smart home network which will be able to produce and supply a household with fresh vegetation grown indoors. Incorporating the connectivity aspect into the device will be a trait of emphasis.

The design development must explicitly focus on finding a way of reducing water usage and transportation. In addition, it must overcome the limitation of the household location and the surrounding climate environment as it will be targeted to a worldwide consumer market.

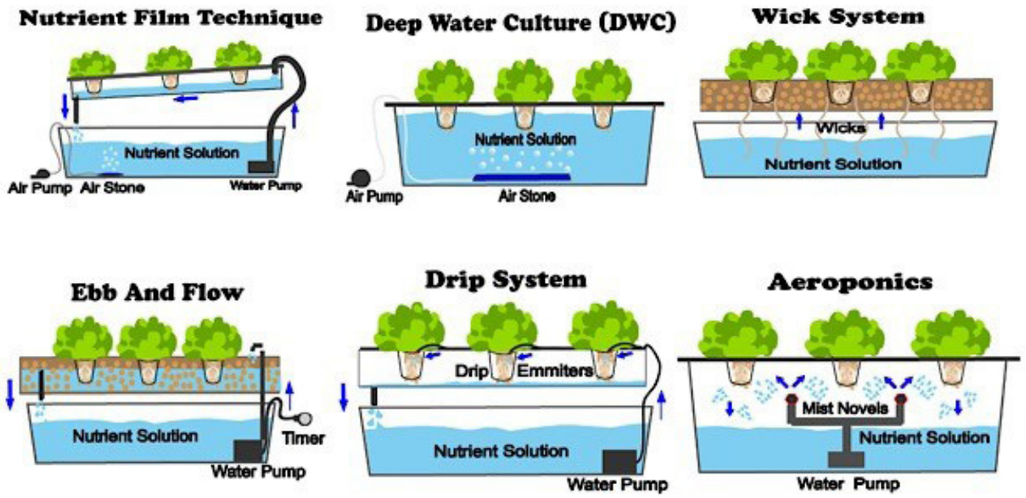
Objective: To design a single autonomous hydroponic smart device connected to the 'smart home network'. With a goal of opening and expanding a future commercial market. Along with that, the transportation of the food produced must be reduced/ eliminated.

HYDROPONICS - A TOOL FOR FUTURE FOOD

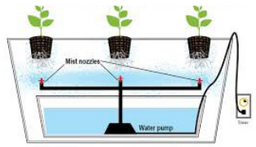
Hydroponic plant growing is a method of growing plants in a nutrient-rich and soil-less environment. In many cases, the pants are gown with artificial lights, that way the growth cycle is not interrupted compare to the natural sunlight limitations. In the UK, for example, hydroponic farming would be highly efficient as one could get on average only 12,29 hours of sunlight per day throughout the year (Project Britan,2013). Hydroponics also have faster growth rates and plants can mature 25% faster. Furthermore, due to the advantage of having the plants in a liquid solution, the plants require up to 95% less water compared to traditional crop farming.

Different methods and growing techniques have emerged throughout the years suiting different scales and environments. Today, there are several methods available designed to suit users' needs for growing at home and commercially.

Img.13 Types of Hydroponic Systems



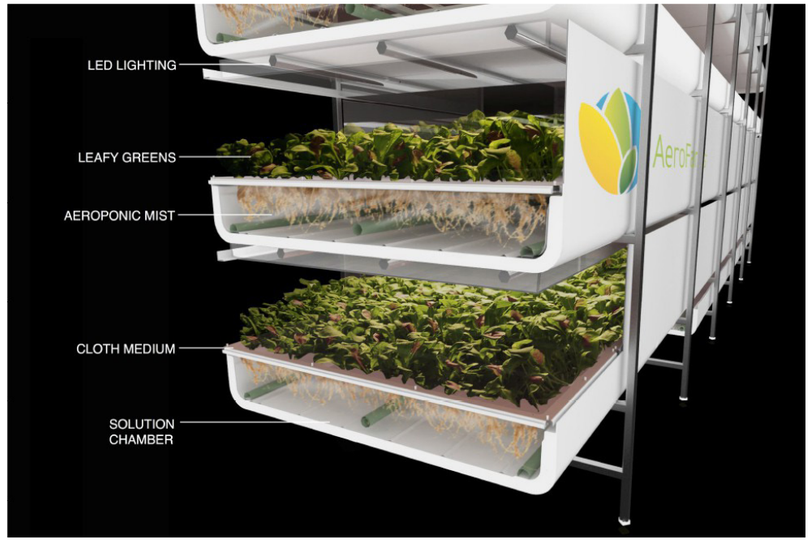
AEROPONICS



Img.14 Aeroponic Principle

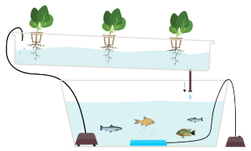
Aeroponics are the most water-efficient kind of hydroponics reducing the usage of water by around 95%. They are also widely used by commercial hydroponic growers, better known today as - vertical farmers. This popularity is due to the aeroponics' convenience for growing vertically as well as horizontally.

What makes them so efficient is the technique used to provide the plants with nutrients. Spray nozzles are positioned under the roots where they occasionally spray the roots with a rich solution creating a mist environment inside the container. The nozzles spray during set intervals of time, therefore, saving water yet keeping the roots always moist.



Img.15 Aeroponic Enviroment

AQUAPONICS



Img.16 Aquaponic Principle

Aquaponic systems are another interesting way of incorporating hydroponics into an artificial fauna (water creatures in most cases). The main difference with traditional hydroponics is the way nutrients are produced and supplied to the plants.

In the aquaponic environment, the fish produce ammonia which then is converted into nutrients with the help of a beneficial bacteria for the plants. Water pumps ensure the flow is always kept constant circulating the water for one container to another.

Img.17 Aquaponic Environment

EMPATHISE DEFINE IDEATE PROTOTYPE TEST

SPACE EXPLORATION AND THE ROLE OF HYDROPONICS

The first recorded mention of hydroponic use dates back to the 19th century. In 1860 the German botanist Julius von Sachs documented an experimental concept of soil-less growing.

Not only that hydroponic systems are regarded as a food production method of the future cities, but they are also been discussed as a food production technique in space. Experiments of aeroponics in space began in the 1990s although they have been in space since the 60s. The results of experiments in space were extremely positive despite the limitations of microgravity. In fact, an experiment recorded 1997 on 'MIR' space station of plants grown aeroponically in space showed better results then plants grown of Earth, as scientists fed the same nutrition to the plants on Earth and to those on the station simultaneously.

Img.18 NASA researcher monitoring hydroponic onions, Bibb lettuces, and Radishes.

EMPATHISE DEFINE IDEATE PROTOTYPE TEST

The image below is displaying NASA scientists at the Kennedy Space Center developing an inflatable cylindrical greenhouse for outer space with the University of Arizona. This cylindrical capsule was built for research tests of long trip space missions (such as Mars exploration and future space colonisation).
Such missions will require large amounts of food supplies to be carried from Earth. This of course would be very inconvenient as weigh is a principal aspect in a spaceship particularly when food supplies must be carried for years to Mars in the space shuttle. Aeroponic systems on the other hand are fully self-sustainable, being able to produce a huge portion of the nutrients required for the crew.

Img.19 NASA scientists at the Kennedy Space Center developing an inflatable cylindrical greenhouse for outer space

MARKET.

AVAILABILITY.

PROSPECTS.

AVAILABILITY

Fresh vegetation and herbs which are now widely available in almost every supermarket and even local stores in the urban areas.

Fresh herbs sold in stores come in pots within a pre-set soil environment. They are usually sold in a mature stage of the pant's life where they are ready to be harvested. Because of that, the majority of the herbs available in the supermarkets (with some exceptions) must be consumed in a few weeks time from the time they have been bought. What's left as waste after consumption in most cases are the plastic pots in which they come with and the plastic wrappings around them.

Img.20-22 Fresh vegetation in supermarkets

EMPATHISE DEFINE IDEATE PROTOTYPE TEST

The majority of the online market stores offer a variety of robustly assembled hydroponic systems and online users seem to give them reviews of great validity and effectiveness. However, although they dominate most of the commercial market, they are largely focused on consumers who have enough space and the right environment to accommodate such systems. Their production capacity is often much higher than what an average household consumption is. Therefore, these types of systems are primarily targeted to small businesses, restaurants, and customers living in non-urbanised areas.

Atami Wilma 4 Pot Complete Dripper System Grow Kit Hydroponics

£72

Img. 23

10 Pot DWC R Root Rapid Hydroponic Deep Water Culture System

£270

Img. 24

Small commercial brands for an Indore growing are available on the market and they create minimal to almost no competition. Distinct similarities in the characteristics of these brands are the operational functions and features they possess. The majority of the products are almost 100% exclusively made out of plastic. Because electrical components are narrowed down to only LED grow lights beginner users(which are the target market for these brands) seem to find themselves unable to understand what kind of care the system and plants need. Therefore, failures in the grow cycle are still very common, due to mistakes or lack of knowledge.

Img. 25

G187 Garland Micro Grow Light Garden

£49

Img. 26

VegeBox Table Smart Indoor Garden | Hydroponic Grow System

£110

WHAT CAN BE GROWN HYDROPONICALY?

There really aren't any limitations to what could be grown in a hydroponic environment. Of course, other factors like space and proper equipment can limit the specter of opportunities of growing at home, but overall, it all comes down to one's desire.

Generally, seasonal salads, herbs, and berries fruits are most likely to be seen in a hydroponic greenhouse. They are all considered to be very easy to grow and take care of.

Img.27 Lettuce

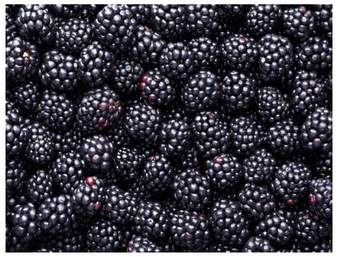
Img.28 Basil

Img.29 Chili Peppers

Img.30 Cherry Tomatoes

Img.31 Blueberries

Img.32 Blackberries



Img.33

EMPATHISE DEFINE IDEATE PROTOTYPE TEST

VERTICAL FARMS - NEW APPROACH TO URBAN FOOD PRODUCTION

Commercialising hydroponic systems for production has been turned into a business for quite some time. Big scale commercial settings are expected to popularise more with the increase of population in urban areas and the limited space for crop production around cities. Vertical farms reduce transportation costs as they are mostly maintained and constructed near or inside urban areas. The vertical position of the crops and the aeroponic approach save not only space for production but they also increase the production rates exponentially.

A great example of the new coming wave of commercialised vertical farms is the New Jersey-based company- ‘‘AeroFarms’’. Stared in recent years the company has seen very promising results along with encouraging customer satisfaction.

Img.34 ‘‘AeroFarms’’

In a discussion of the future urban living, a team of National Geographic has asked experts at the architectural and urban planning firm Skidmore, Owings & Merrill (SOM) to design a city of the Future. Their vision was articulated in 5 scales and 10 key principles.
One of these ten key principles was pointed out as ‘Urban Farms in gardens ‘ - New communities and development take advantage of advanced hydroponic technology for urban farming.
(National Geographic)

Img.35 JASON TREAT, NGM STAFF. ART & SOURCE: SKIDMORE, OWINGS & MERRILL (SOM) & National Georaphic

BIOSPHERE 2

Biosphere 2 is the largest enclosed ecosystem ever created by humankind finished in 1991 in Oracle, Arizona. The system was built to recreate the complex ecosystem of the Eart in a segregated environment with an aim to demonstrate the likelihood of human existence in an artificial Earth-like environment and life outside Earth. Biosphere 2 was designed to have 5 habitats Ocen, Tropical Rainforest, Fog Desert, Savanna, and a mangrove Wetland, spread across the whole complex.

Img.36 BioSphere 2, Oracle Arizona

Img.37 Inside BioSphere

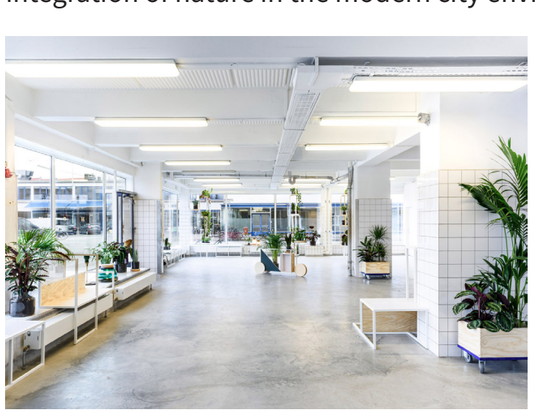
In September 1991 a team of 8 participants was selected for a project inside Biosphere with an initial test period of 2 years. Participants were to live inside Biosphere2 only by the sources produces by the artificial earth-like system. The goal of the experiment was to document and evaluate prospect human life depending exclusively on the surroundings. Along with the five internal ecosystems mentioned previously, the group had an agricultural area, living quarters, laboratory, and common areas for human interaction. Unfortunately, the experiment wasn't completed for the full duration as intended due to an internal conflict between the participants.

The Biosphere experiments provided me with some ideas and answers to the creation of soilless food production in densely populated areas. Reading about the project, the experiments in BioSphere specifically answered some concerns with human interaction and involvement later in the project.

EMPATHISE DEFINE IDEATE PROTOTYPE TEST

SPACE 10

Space 10 is a danish-based, modern-day design lab specialising in observing scenarios of sustainable living. The lab works along with companies and organizations on projects and concepts with an idea of finding simple and ethical solutions. Some of their remarkable work looks deeply into the idea of the inevitable integration of nature in the modern city environment.



Img.38,39 Space 10, Copenhagen

Img.40 A sustainable home view, EFFEKT Architects for SPACE10

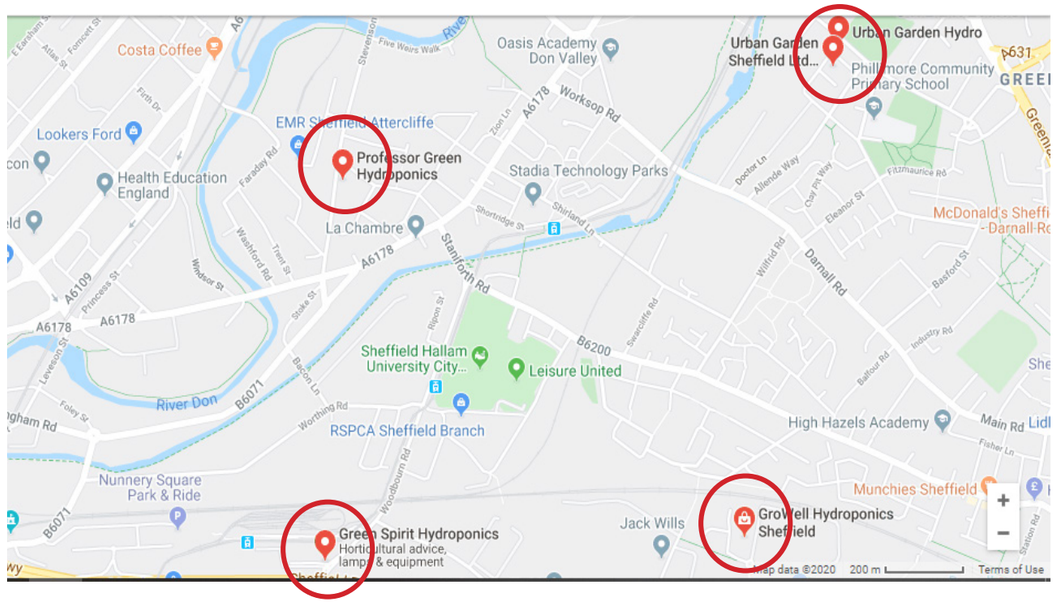
EXPLORATION & EVALUATION

EMPATHISE DEFINE IDEATE PROTOTYPE TEST

HYDROPONICS IN SHEFFIELD

In a relatively early stage of the project, I mapped out stores and businesses in the region of Sheffield dealing with hydroponic systems. From a short visit to these local stores' websites, I found very useful information such as types of growing lights, watering systems, growing lights, a variety of media, etc.
To find out more, I arranged visits with three local stores: ''Green Spirit Hydroponics'', ''Urban Garden'', and ''Growell Hydroponics'' in the industrial region of Sheffield. Arranging the details on the phone, the shop staff granted me permission for documenting the interviews. Additionally, I specifically asked for permission of taking photographs of the equipment in the shops which was also kindly authorised by the shop's personal.

Img.41 Hydroponic Stores in Sheffield



‘‘GREEN SPIRIT HYDROPONICS’’

S9 3LQ

The staff at ‘’Green Spirit Hydroponics’’ introduced me to a few of the basics of hydroponics. Discussing the common practices and tools I found out that simple hydroponic systems do not need specific growth boosters for certain plants. In fact, most people use general fertilizers which provide the essential nutrients to all types of plants. Later, this finding turned out to be an advantage of a feature in the final design of my product.

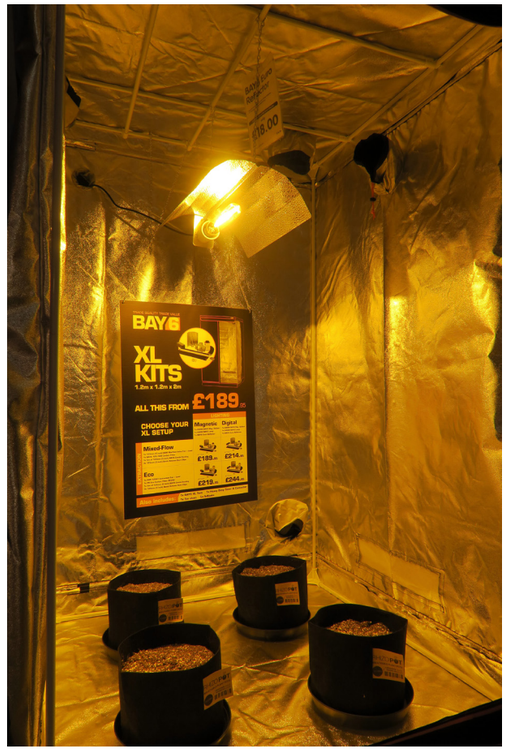
Img.42-46 ‘‘Green Spirit Hydroponics’’ Sheffield

‘‘GROWELL HYDROPONICS’’

S9 4WU

‘‘Growell’’ had a very well equipped store with a large variety of lights, media, growing tents. Here I really got to experience first hand the enormous scale and variety for different purpose hydroponics.

Img.47-50 ‘‘Growell Hydroponics’’ Sheffield



‘‘URBAN GARDEN’’

S9 5DX

At ‘‘Urban Garden’’ the store staff were quite intrigued to show me interesting hydroponic systems that were implemented for different purposes around the world. For instance, an interesting Ebb and Flow system designed for hydroponic farming in regions with limited water access. Using copper sheet on the bottom of a pot prevents the roots from growing any further down as plants are quite sensitive to copper texture. The staff were also very compassionate with the nature of my project when I shared my ideas with them. They generously provided me three booklets of hydroponic literature to support me with further reference on the project.

Img.51-56 ‘‘Urban Garden’’, Sheffield

CONCLUSION OF THE EXPERT’S OPINION & NEXT STEPS

Discussing the project’s topic with the experts in the shops I decided on stating my own hydroponic system in my student room in order to examine and document the process closely from planting to harvesting. Due to the niche focus of my project, the first-hand examination was perhaps the most genuine way to discover and evaluate a user’s experience of a hydroponic growing process by putting myself into the user’s shoes. The tests will essentially help me experience the difficulties and the convenience of soil-less growing at home.

A common thing I have noticed in all the shops was that the equipment they had was not meant for small scale practice but rather for professional and semi-professional purposes. An employee of ‘‘Urban Garden’’ suggested a hydroponic compact system of IKEA as an initial testing rig for the project. He noted that for the purpose of my project the system would be able to fully demonstrate the hydroponic process.

Img.57 IKEA Sheffield

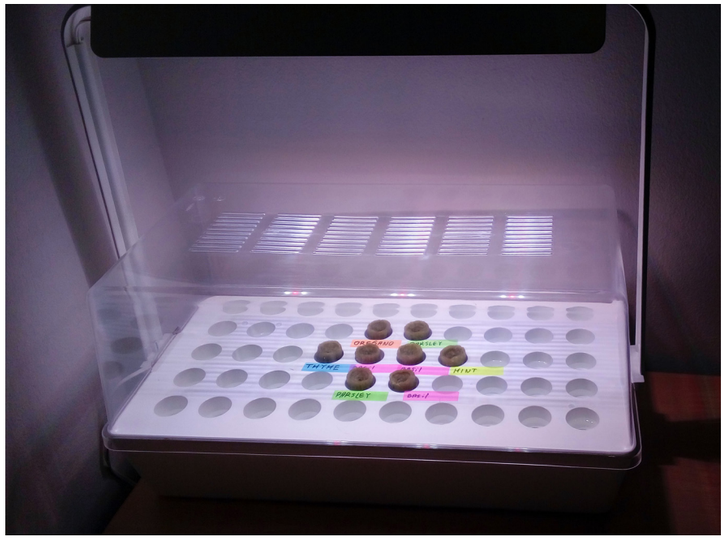
FIRST-HAND OBSERVATION

To begin the evaluation process I bought the ‘VÄXER’ hydroponic system of IKEA. The system’s set consisted of two containers, two types of growing media, a liquid fertilizer, and an LED Light.

First, the light, cables, and containers must be assembled following the infamous ‘Do it yourself’ IKEA assembly instruction sheets. Sadly, I couldn’t plant the first seeds right away as I realised the seeds where not included in the set. Therefore, the process started two days later after I purchased seeds online.

Once the seeds arrived, all I needed was the growing media and water in the ‘Germination Container’. The first phase of germination requires rockwool as a growing medium. The small rockwool cutouts have to be soaked in water for 3 minutes and after that, they are placed in the opening holes of the container.

Img.58, 59 Fertilizer and Germination Container



EMPATHISE DEFINE IDEATE PROTOTYPE TEST

The water level only reaches the bottom of the Rockwool pieces ensuring they are always moist. The seeds then must be carefully placed on top of the rockwool where they will start to germinate.

For the sake of the experiment, I bought herbs that demand slightly different environmental conditions, such as Basil, Parsley, English Thyme, Mint, and Oregano.

The seeds usually start to show signs of germination in a few days, however, they must reach a certain hight of around 5 centimeters before they can be transferred to the second container with solid media. This first growing phase takes 3 to 4 weeks. During this first phase, one should only assure that the water levels are as high as instructed. On the inner sides of the container, are engraved two horizontal lines showing the maximum and minimum recommended level of water inside the container.

In roughly four weeks the herbs developed significantly and they had to be transferred to the second container. The second container is very similar to the first one, the only visible differences are the larger cutouts and slots for the pants and also the opening for water refillment. The reason why the second

Img.60,61 VÄXER’s growing containers

container is made with these bigger slots is because they will accommodate the additional media that must be added. This second type of media provided in the set was a bag of small pumice stones, the stones surround the Rockwool piece with the plant's roots grown inside it, that way the heavier media secures the plant and roots from tilting and sinking.

In this second stage, I had to keep an eye not only on the water level but this time I had to also add liquid fertilizer. With the fertilizer, the growth increased significantly, in just a week the pants doubled in size. I had to top up the system with freshwater and fertilizer almost every other day, as the expediential growth also demanded more water than before.

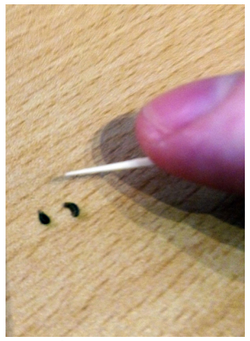
In roughly six-seven weeks from planting the seeds, the system produced fully grown herbs ready for harvesting. Based on general information I found online on the types of herbs I planted, the VÄXER set managed to reduce the full growth cycle by approximately 20% in contrast with the expected growth time of these specific herbs in a traditional environment.

Img.62 Main Container

EMPATHISE DEFINE IDEATE PROTOTYPE TEST

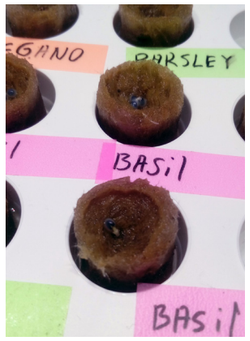
Img.63

Img.64

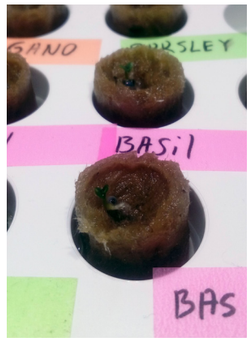


Seeds Day 1

Day 1



Day 4



Day 8

Day 11

Day 15

Day 17

Day 36

Day 58

Day 61

Img.65-74 Growth Progression

FINDINGS & REFLECTION

Throughout the whole evaluation phase which continued for 5 months, I continuously documented in detail features and obstacles which I noticed are quite inconvenient and could be reconsidered in order to ease and improve the user experience.

-The first very apparent thing is the two separate containers used for germination and the mature phase. The use of two containers for the two growing stages is a common practice not only with the VÄXER set but with many other sets I found online.
This separation is particularly insufficient if the set has only one light source (as VÄXER and most other do) which could illuminate only one of the containers at the time. As a result, if some of the plants in the germination container are developing slower they can not be left to develop fully and must be moved to the second container prematurely with the rest of the fully developed ones as there will be no light source left on top of the first container.

-The two containers obviously take twice as much space, which is an issue for small apartments and limited spaces as for example a student room.

-The only reason IKEA has designed the system with two containers is because it uses two types of media (rockwool and pumice stones). However, professional hydroponic systems complete a whole grow cycle with the use of only one media type. Considering the affordable price of most hydroponic devices of this class, I believe IKEA's decision to integrate two container types and two media types is purely profit-driven.

-The biggest issue I faced was calculating the correct dose of fertilizer when I had to add nutrients to the water. The instruction book provides a precise dosage of fertilizer needed to be added (12ml) to a full container of water (3,6l~). However, when the water level drops by a little in few days, there is no way to calculate what amount of water has been used. And therefore, it becomes very difficult to measure the right amount of fertilizer needed. Moreover, the fertilizer is meant to be measured in its bottle cap which have indications of only 6ml and 12ml.

USERS OF AUTOMATED HYDROPONICS

After I tested and evaluated the process of growing plants indoors on my own I was keen to find more about the experiences of others growing hydroponically at home. To short-list the search for responses I found repetitive series of answers to these broad questions: ''What challenges other people have experienced while growing plants with hydroponics devices?'' and ''What they have found useful and not so useful?''

''One thing I would say I had to buy the seed kit separately which I think isn't really great I would expect this product to come with a starter kit inside the box.''

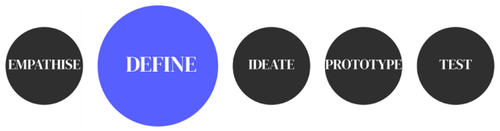
Anonymus user, Amazon

''Purchased to facilitate herb and salad growth in a rental property.This was so successful that I was also obliged to purchase the next model up.''

Anonymus user, Amazon

''Despite regular water and nutrient input, some plants refused to grow more than a couple of inches and had fungus in their roots.''

Anonymus user, Amazon



DESIGN GUIDELINES

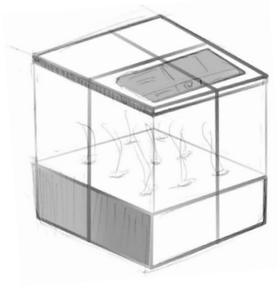
Current Hydroponic Devices		My Design Focus
plastic bodies	→	Fiber-reinforced concrete
two types of media required	→	One type of Media with pre-set seeds used throughout the whole grow cycle(Rockwool)
liquid fertilizer	→	Dissolvable nutrient tablets
Poor understanding of the plants' needs	→	Sensors measuring and alerting the user through an app and an interactive display when action is needed
Often two separate containers used	→	A single body
		Interactive Display
		Ability to control number devices from of the same brand through an app.
		Individual Identification Number of every device.

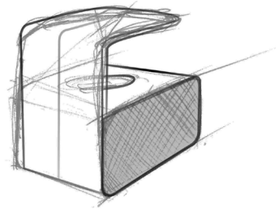
CONCEPTUALISATION

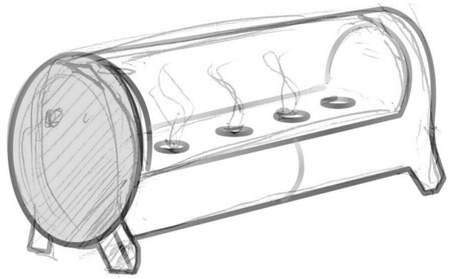
EMPATHISE DEFINE **IDEATE** PROTOTYPE TEST

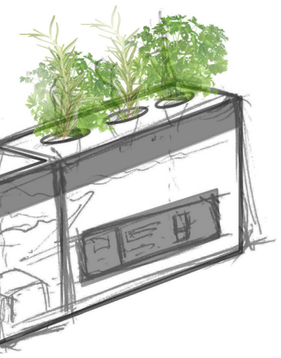
EARLY DEVELOPMENT

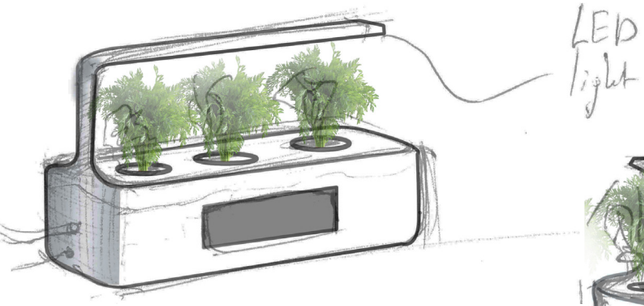
To narrow down the findings from a broad selection of ideas I started exploring various concepts, without an initial restriction of form or features. Nevertheless, suggestions of the elements which I outlined in the design guidelines where hinted in most of the generated concepts.

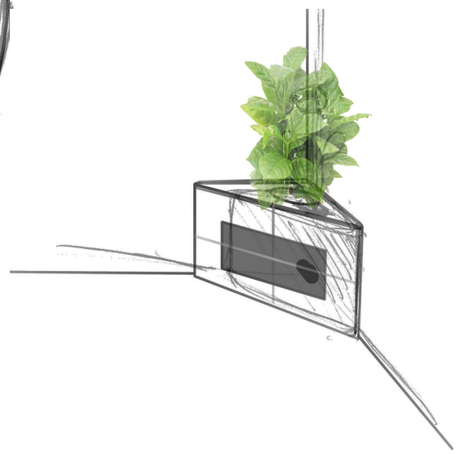


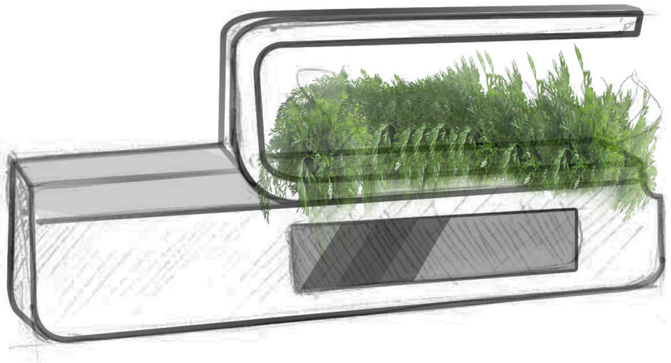


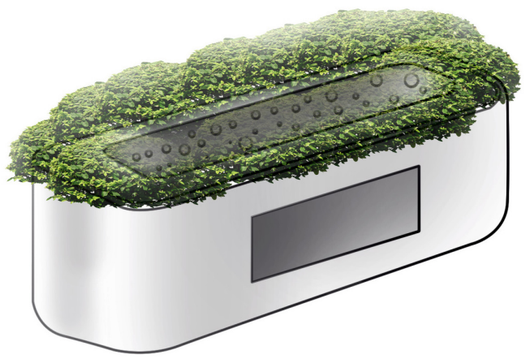


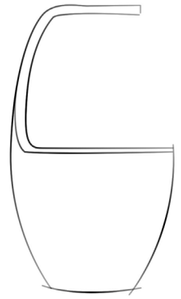




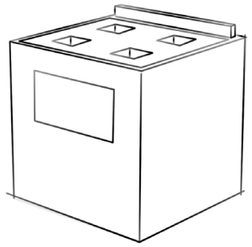


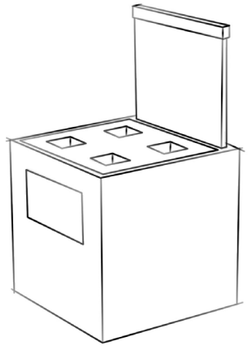


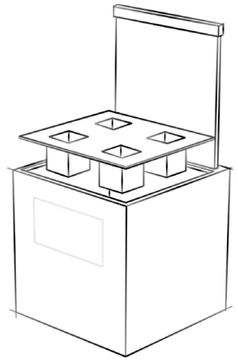




Two concepts with quite contrasting characteristics stood out. In the first concept (top image) I explored a shape resembling a traditional flower pot but with a twist of a fluid transition of an extrusion that nicely houses the LED light, where it points down towards the plant opening. My concern about this design was in connection with incorporating the electronics as the round outer surface would greatly restrict having a traditional flat display. Therefore a bespoke display must have been adapted.



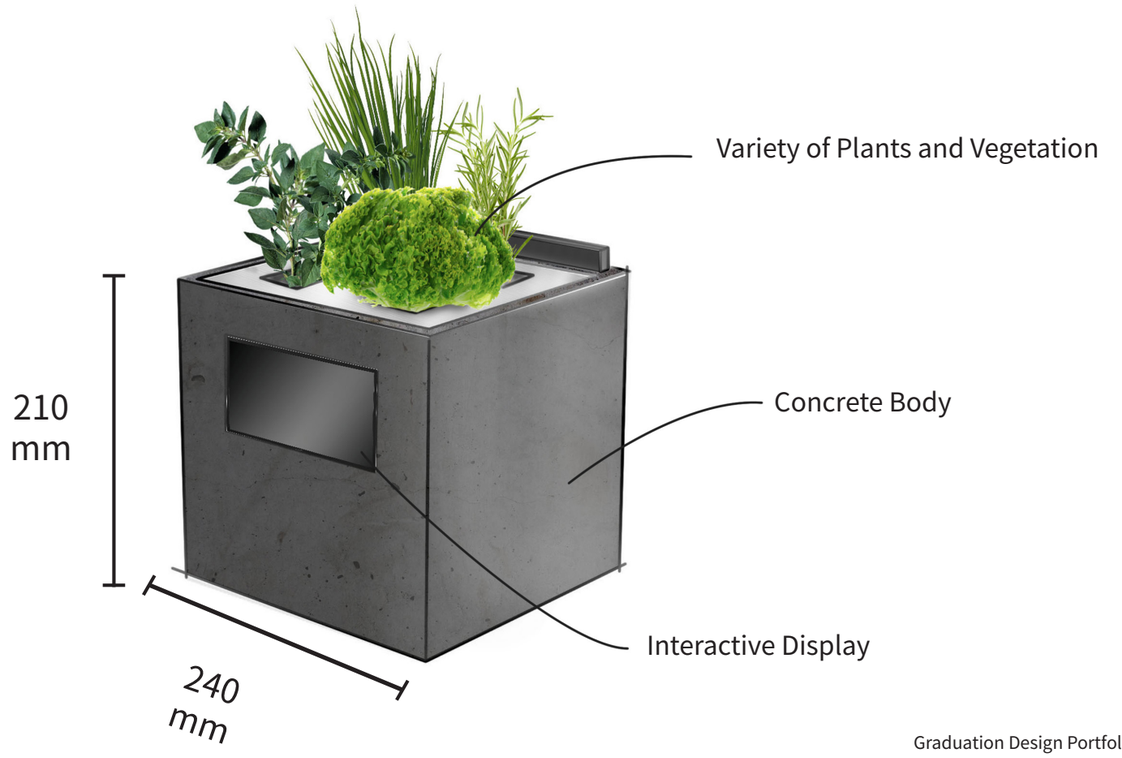




The other concept was developed from the basics and I slowly started adding additional elements and features to the design. This concept was developed in stages of revision, modification, and improvement based on feedback and data I was getting from my test of the system at home.

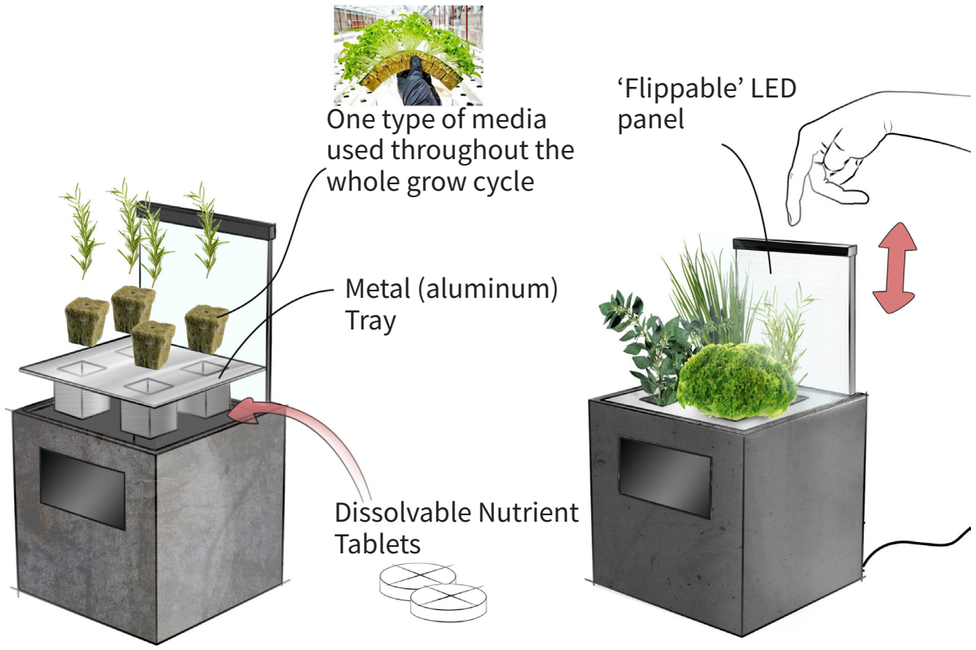
After a series of concepts and refinement of details, I decided to further develop the concept of the basic square-shaped device as it positively fulfilled every essential feature that was set in the design guidelines.

Furthermore, I particularly determined relatively early the material combination of concrete, glass (the display), and metal. The reason for selecting these particular materials was sustainability and endurance. The material had to ensure the long-life of the product, resistance to wet conditions, and the ability to be reused and/or recycled.



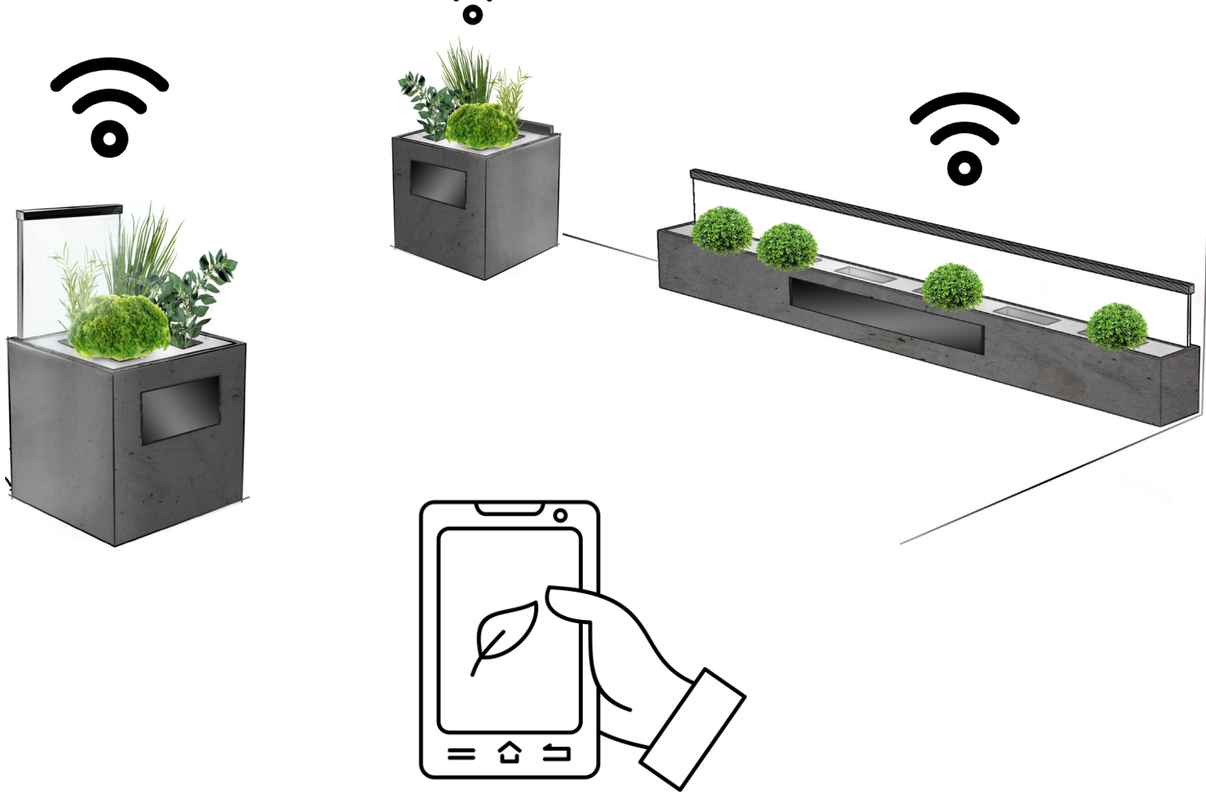
Although the concept was roughly defined, some elements such as the ‘flippable’ light panel raised concerns of efficiency and practicality due to the large amount a power that will be used to supply a whole pannel with dozen of LEDs, rather then a just a strip of LEDs pointed towards the plants. Therefore, a new mechanism of only a few LEDs was developed along with a defined mechanism for the storable light.

Experiencing the inconvenience of measuring the right dose of the liquid fertilizer every time water had to be added, the Idea of dissolvable tablets came into my mind. With set portions of the nutrients in each tablet, the tablets will eliminate the disadvantage of measuring certain quantities of toxic substances.



Perhaps the two reasons why this concept stood out from the rest were - first, the consolidation of unique and sustainable raw materials. And second, the minimalistic form allowing easy integration of an interactive display and electronic components.

I further updated the concept of not only having a display on the product but also having an app that one could use to connect and control all devices of the brand, from a smartphone. With the app, one can be alerted for an action even if he/she isn’t close to the device.



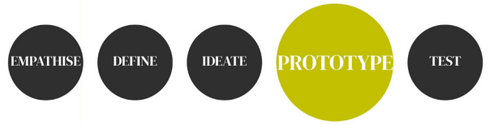
USER INVOLVEMENT, INTERACTION, AND EXPERIENCE

The nature of the device will aim to ease and reduce human interaction in the process of growing organic food. However, as the product will be targeting users in the home environment first, the user involvement in taking care of the plants' lives will be an essential aspect of the design.

Creating an emotional connection of care between the user and the product is a difficult yet important piece for the impact of the product. That being said, I decided to also break down the user involvement strategic approach into physical and digital interaction.

For the physical aspect, the user will be taking care of the water level inside of the device, making sure the plants get enough water. An additional task for the user will be the provision of nutrients to the water solution. This will be done with the convenient dissolvable tablets.

To support the overall user experience an interactive display will indicate the status of the plant's conditions. Furthermore, an app connected with the device (or series of devices) will maintain and record everything happening inside the device by sending information and instructions to the user through an app.



BASIC PROTOTYPE

Straight after the first rough concept, I went to the workshop to assemble a quick cardboard model in order to determine the rough size and some of the major features such as the storable light panel and the tray.

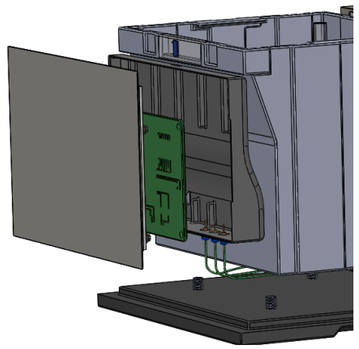
This initial cardboard concept turned out to be slightly smaller than what the final product came out to be. The slight size increase was mainly caused by component arrangements and some aesthetical features.

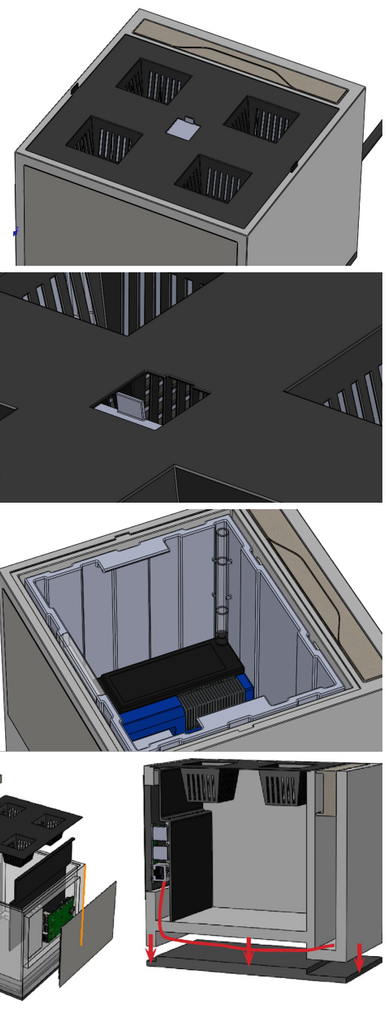
Unfortunately, this was the only prototype that was generated before the workshops' closure.

Img.75-77 Cardboard Prototype

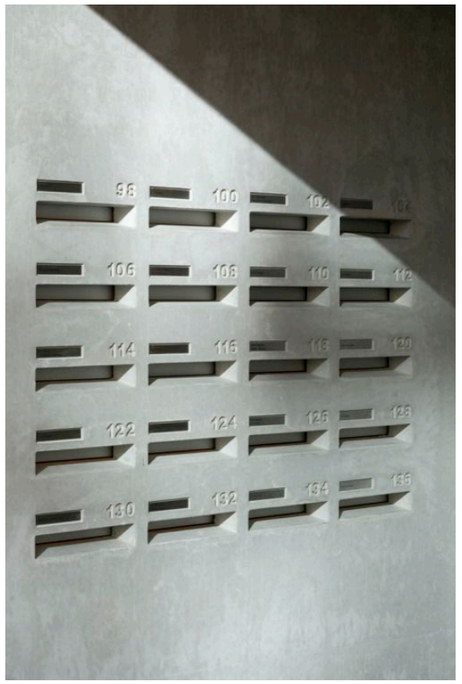
CAD

The development of the product in CAD continued for three and a half months. Countless alterations and changes were made on the components' detailing, positions, arrangement ect., until reaching the finalised CAD model. Due to the large quantity of 3D concepts developed I will be referring only to essential bits of previous features in the upcoming sections of the Logbook which in one way or another have impacted the final design.

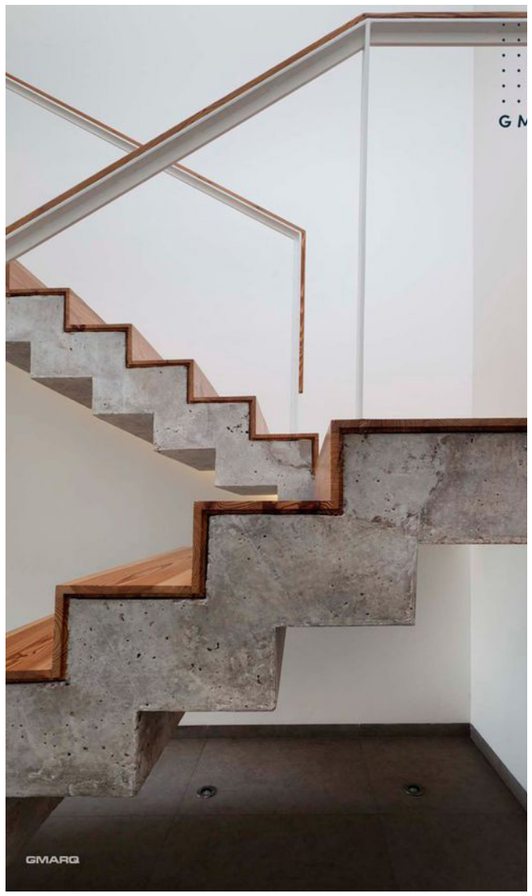




CAD Development



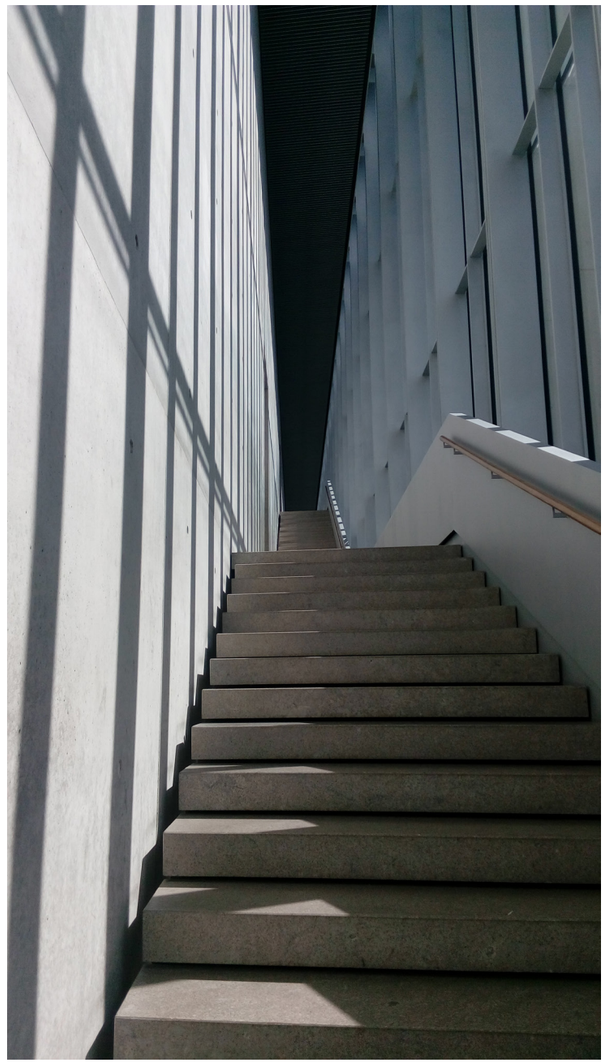
Img. 78-80



While developing the ‘Square’ concept, I started looking into examples of highly enduring materials. I envisioned the product having strong and contrasting characteristics achieved by exposing the natural look in a blend of textures.

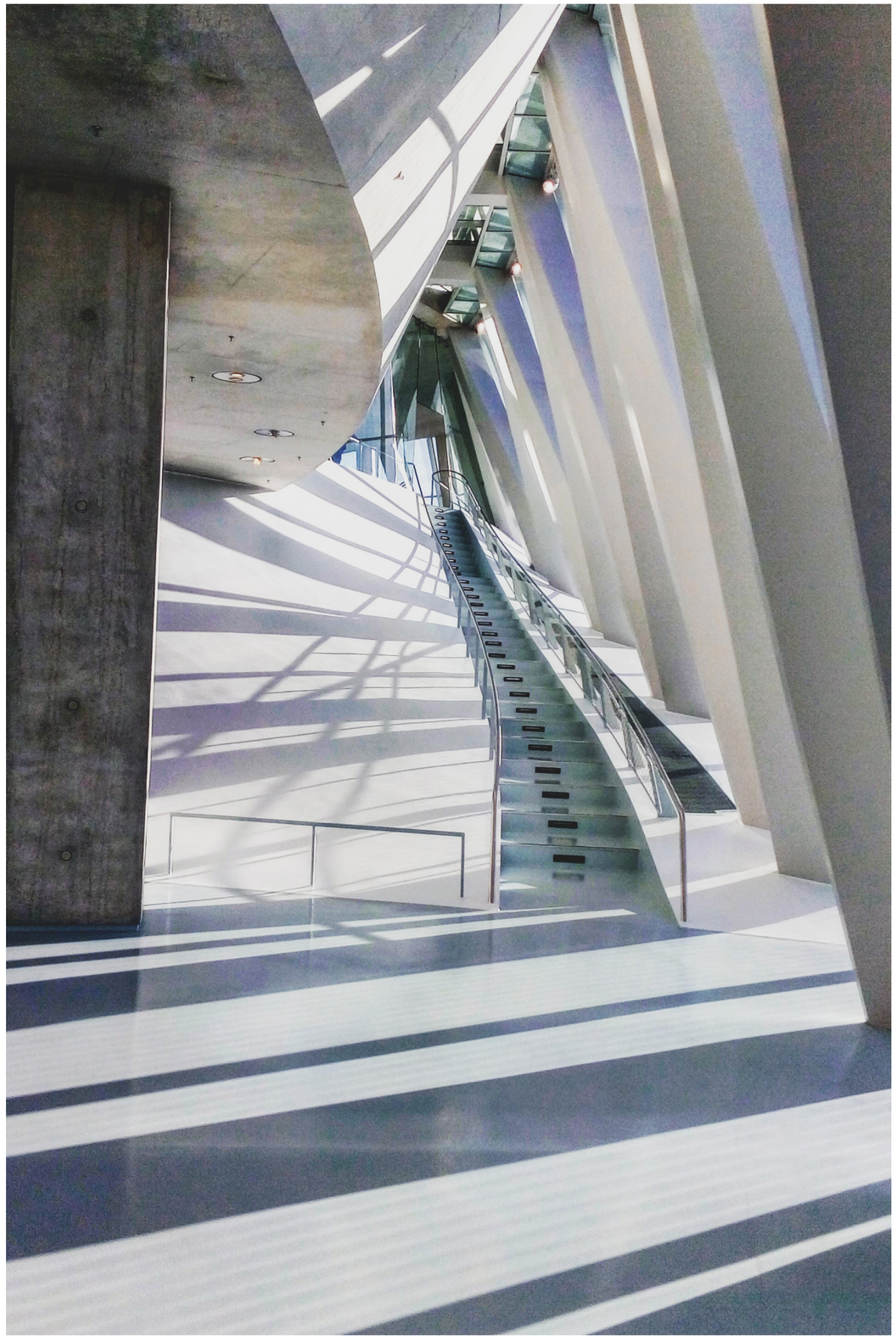
The materials and texture of the main body of the device will impose a primitive yet essential form that resembles an aesthetical style based purely on architectural construction techniques. Principles of the ‘Architectural Functunalism’ played a major part in the choice of the materials and overall shape of the product.

Smooth concrete surfaces, metal, and reflecting dark-shaded glass features. These materials exhibit cold and distant style, yet they are also patterns of establishments constructed from such materials which are also seen as symbols of stability, reliability, and prosperity. Banks, government buildings, and corporational headquarters are some of the institutions to adopt and recognise the cognitive connection of one’s perception of this style’s appearance.

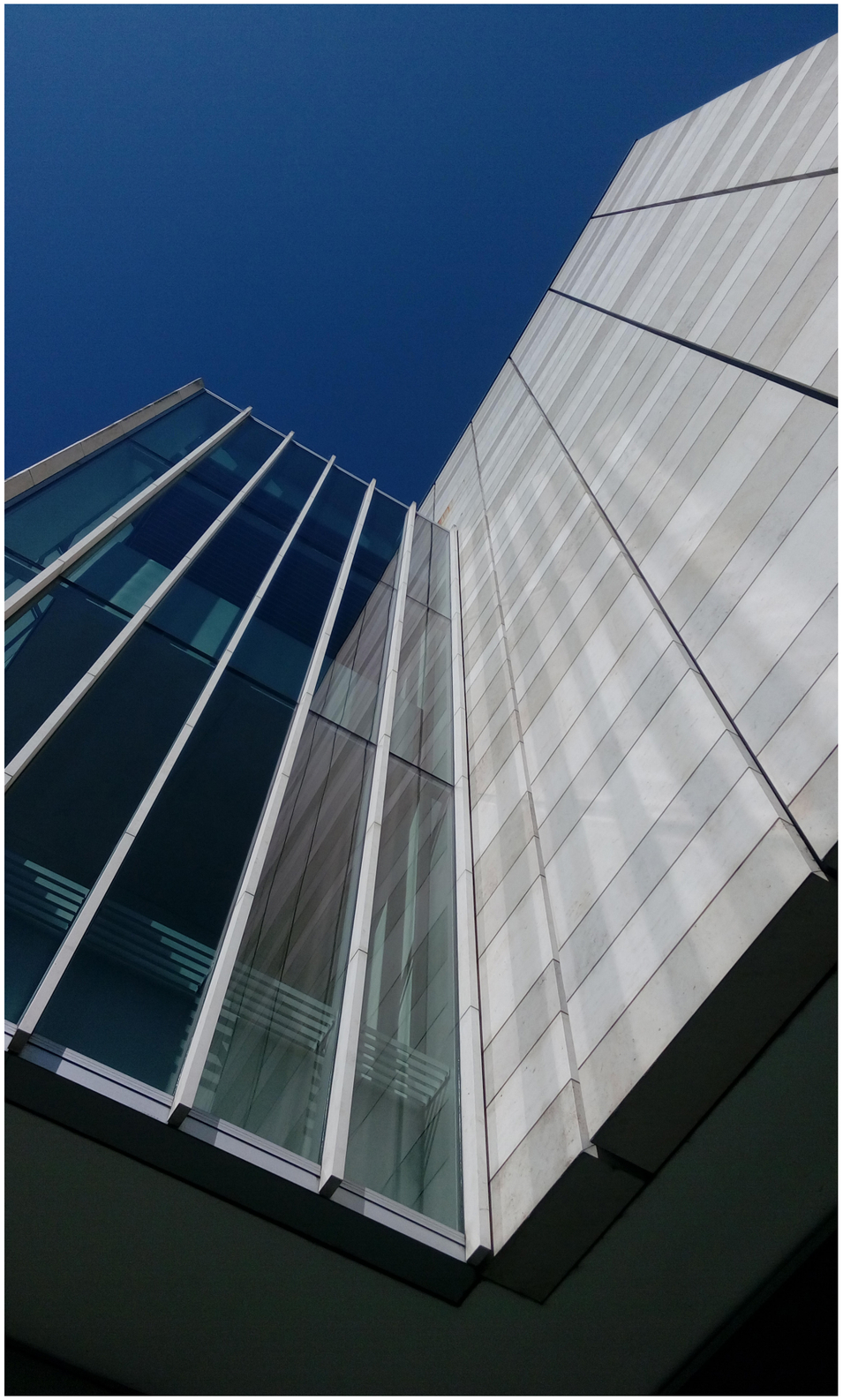


Img.81 Art Gallery, Ulm

Img.82 National Bank of Denmark



Img.83 Mercedes-Benz Museum, Stuttgart



Img. 84
Art Gallery, Ulm

Img.85 City Library,
Stuttgart

USER PROFILE/ TARGET MARKET

The year is 2032. Kaito is a 32-year-old network developer in one of the largest solar energy companies in the world and the largest in Japan. He lives in Tokyo, by himself, in a small one-bedroom apartment in one of the busiest residential areas of the city.

He has an active professional life filled with frequent travels and long working hours. Despite the busy schedule, Kaito follows a healthy lifestyle trying to consume fresh locally produced food as the government started to encourage the local production due to the extensive increase of the carbon footprint from the transportation of seasonal food grown abroad and transported to Japan.

Img. 86
Kaito

Img.87 Modern
1 bedroom apartment

EMPATHISE DEFINE IDEATE PROTOTYPE TEST

Tokyo has been trying to increase and encourage the production of locally grown food but has been facing major difficulties.
First, the large number of inhabitants in the whole of Tokyo's metropolitan area, and second, the limited space for urban farms in the densely planned city landscape.

Due to the busy lifestyle of Kaito combining work and personal life similar to most working people in Japan he is rarely home to take care of an indoor garden.
This is perhaps why an automated Indore hydroponics would become increasingly popular for many Japanese in upcoming years. Hydroponics' minimal resources required to operate combined with the slightest care, and network mobility will eventually help to satisfy a lot of the demand for fresh locally produced food in the densely populated megacities of the future.

The product will primarily target consumers living in urban areas, in small apartment s and limited space. Students, couples, and young professionals.

Img.88 Tokyo Landscape

USAGE SCENARIOS

Although the ideal scenario for the device would be applicable in small living spaces I acknowledge that the product must be suitable for any type of living environment regardless of size and arrangement. The device must still serve its purpose and provide the user with the same levels of comfort and efficiency no matter if the premise is a small urban apartment or a large family country house.
To better address the bigger households which would demand more fresh food, I envisioned a concept of a larger device with a more production capacity. which will be more suitable for such households.

FACTORS TO BE CONSIDERED

User interface (display & brand app)- most of the interaction with the device will be done through either the app or the display. Therefore, a conceptualisation of the interface will be crucial for the user experience.

Network Connectivity- internet connection, of course, must be considered as the device will be connected with a local network. Therefore, an emitting point will transmit a signal which will be recognised by the local network.

Power Supply- since the entirety of the device would require a supply of power for a few electrical components such as light, electrical control board, sensors, etc. Proper electrical management must be also carefully considered to fit the design and technical language.

Natural sunlight - all plants need light in order to grow and mature. However, artificial lights not only provide light for the plants, but they also speed up the growth cycle by roughly 25% as they can be left on forever which ultimately results in faster production.

Img. 89-91 Common device' locations

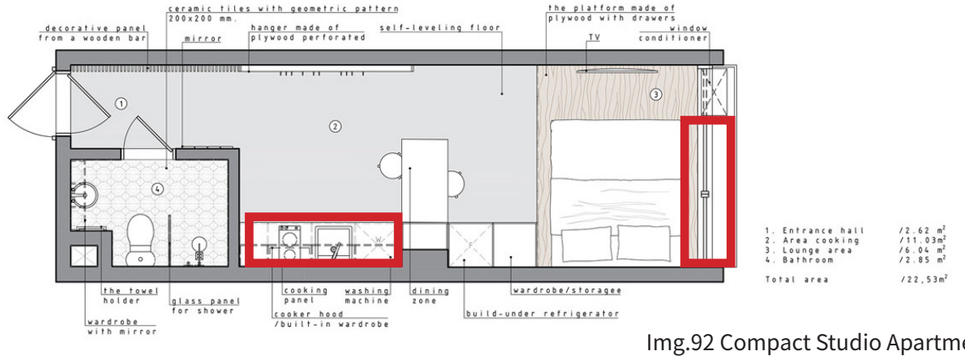
THE DEVICES' LOCATION IN THE HOME ENVIROMENT

To determine the optimal location for the hydroponic device in the home environment I collected and analysed online data from users of hydroponic devices as well as users of conventional flowerpots.

I examined and grouped the data showing the most common places in the home environment where people prefer to locate their plants and greens.

I noticed certain repeatable patterns in the user's choices for conventional flowerpots. As the traditional way of growing plants requires a certain amount of natural sunlight, people tend to place traditional flowerpots in bright places and specifically on windowsills. On the other hand, users of hydroponic devices tend to locate the device based on their usage convenience as the sunlight does not play a factor in this case. The most predominant area in the house for hydroponic devices shown to be the kitchen countertop.

Sources can be found in the Bibliography.



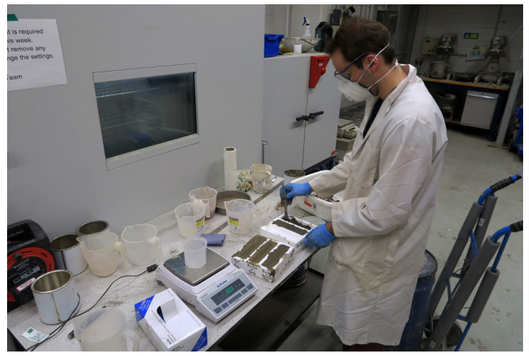
Img.92 Compact Studio Apartment

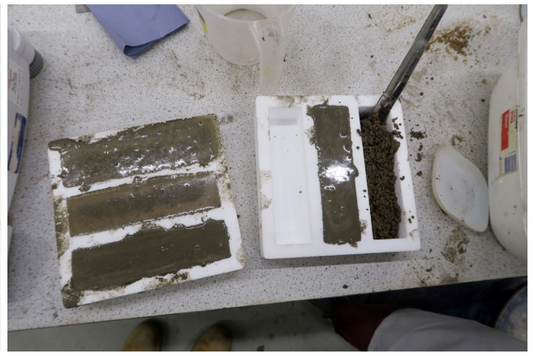
MATERIAL EVALUATION

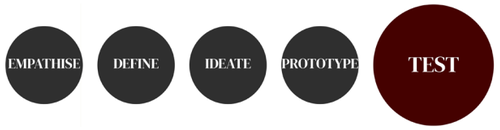
To assess the material for the main body of the product I conducted several tests of concrete mixtures. The body will be cast in one piece with a challenging 14mm wall thickness. Therefore, I sought advice and shared my ideas with the experts in the Hammer Workshop who are dealing with building materials and techniques, specifically concrete, on a daily basis.

The aim of the making of these samples was to evaluate the material's strength capacity, finish, feel, and color of the concrete.

Img.93-96 Concrete testings



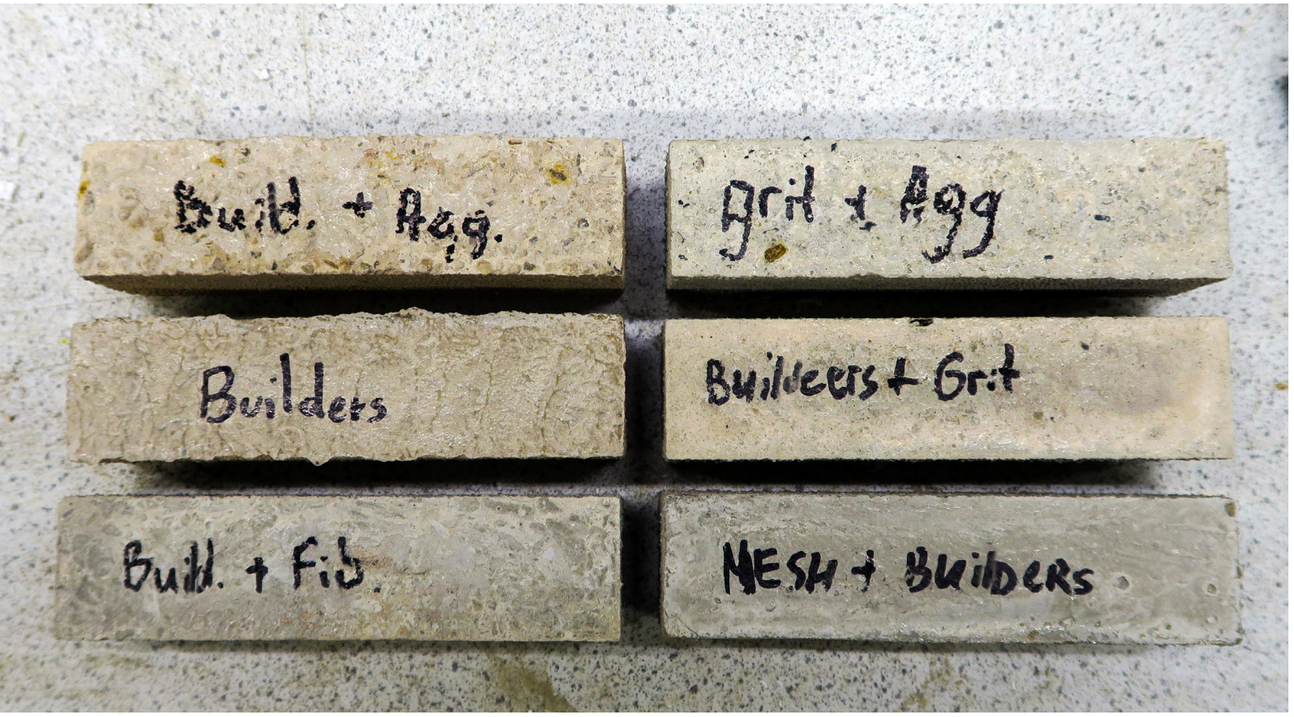


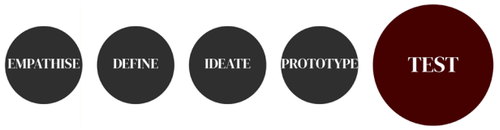


Six samples of concrete mixtures were cast with different consistencies and ingredients. In some were used reinforcements such as steel mesh and iron fibers, in other I explored different ratios of aggregate, cement, and water.

The optimal benchmark of the mixture ration, I found suiting best was 35%-of heavy aggregate,35%-light aggregate, 13% concrete, and 17% water. However, these ratios were adjusted accordingly to the effect that was set for the different mixtures.

Img.97 Conctere samples





To test the strength capacities of the samples the casts must first fully ‘‘mature’’ (which usually takes around 28 days) in order for the test to have any legitimacy. Unfortunately, conducting the tests was not done due to university closure and an unprecedented pandemic outbreak.

Img. 98 Grit 4mm (stones and pebbles)

Img.99 Metal Fibres

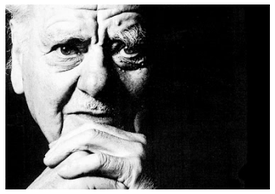
Img.100 Heavy Aggregate

Img.101 Builders (fine sand)

Img.102 Concrete Samples

INSPIRATION

WILLY GUHL — ‘LOOP CHAIR’ 1954



Img.103 Willy Guhl

The inspiration for the reinforced carbon fiber concrete came from two furniture masterpieces using a minimal amount of material yet withstanding the test of time with their great ingenuity of material ratio and innovative techniques.

The loop chair was designed in 1954 by the Swiss furniture designer Willy Guhl who was also one of the first industrial designers in Switzerland. The chair has a full concrete body made in one piece with a mix of cement and fiber particles which give the structure incredible durability and strength.
Although the appearance of the chair resembles an artistic piece rather then a comfortable chair the shape of the design is purely built around the users’ comfort and necessities. Guhl said ‘‘At the center of my efforts, I put people and their living requirements. I want to improve their immediate environment…My products must be useful to people.”

Img.104 Loop Chair 1954

Img.105 Loop Chair 1954

‘ECAL STOOL’

The Ecal Stool is another example of amazing use of concrete in everyday products which again really sparked my curiosity with its contrast of an aesthetical shape and brutal material such as concrete. The chair is yet another piece designed by a Swiss designer - Nicolas Le Moigne, who in fact completed the design of the chair while working on his degree project.

To preserve the structural integrity of the form Le Moigne used again similar material combination to the ones used in the ‘‘Loop chair’’ of cement and various fibers which gave the build an incredible sturdiness over time. Cast in one piece, the chair has numerous applications such as a coffee table, chair, book rack, and more.

Img. 106 Ecal Stool

Img.107 Ecal Stool

Square One

Smart Hydroponic Systems

FINAL CONCEPT

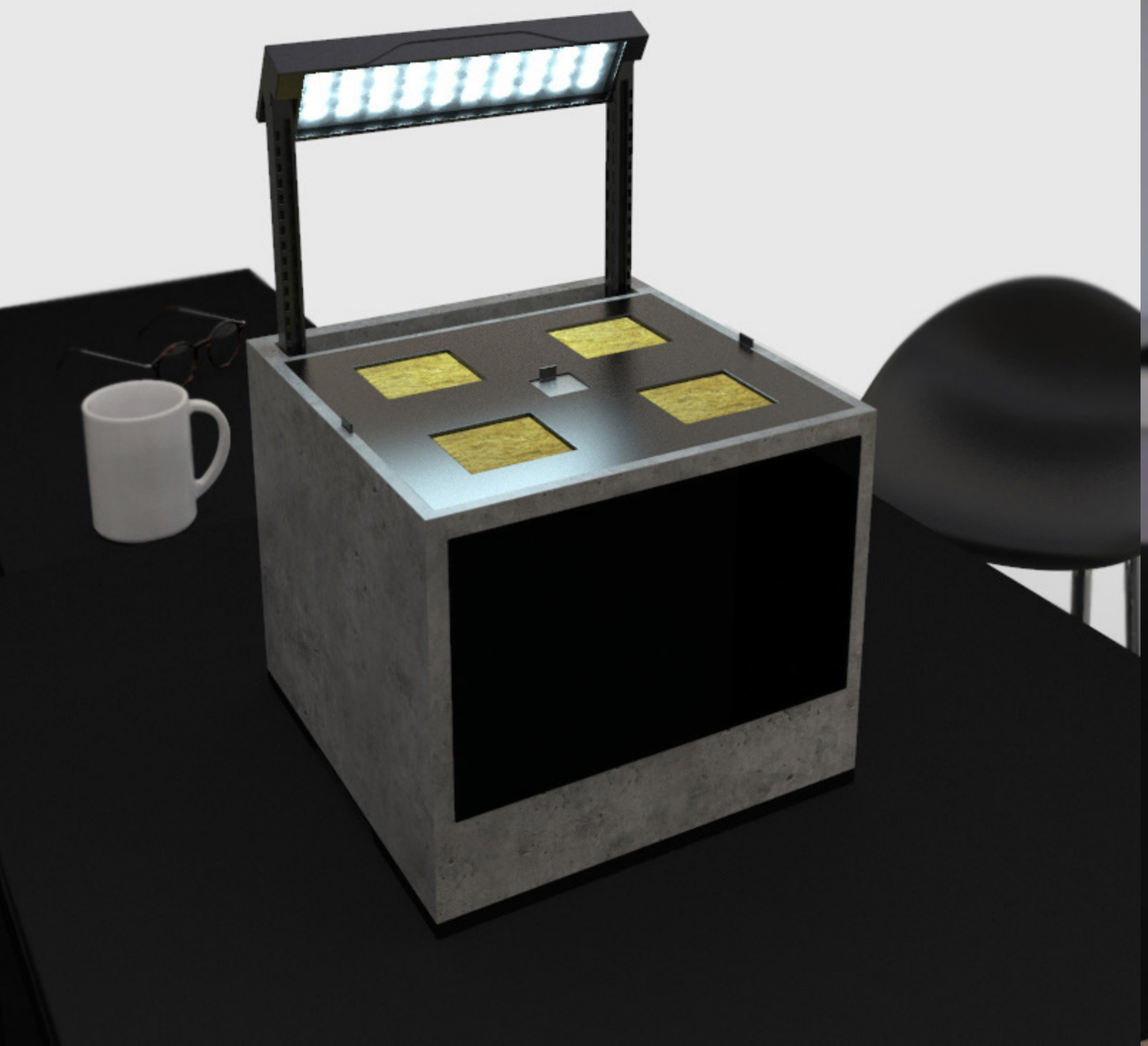
‘SqaureOne’ are smart hydroponic devices designed for the smart-home network. With them, households and families are able to produce fresh and organic vegetation at home faster than traditional methods. Without any effort and negative impact on the environment.

Initially, the product will be released with two models for a range of target users. The rectangle-shaped device of the brand will be primarily targeted to large family households. On the other hand, the smaller square-shaped product will be targeted to smaller households and individuals with limited living space. Nevertheless, as the models share the same brand identity they can be simultaneously operated through the brand's app, regardless of the number of devices in a single household.

With its compact size, the device easily fits in any corner of a modern kitchen, living room, or bedroom. Due to its low voltage electrical components build in, it can be plugged in any traditional power socket.

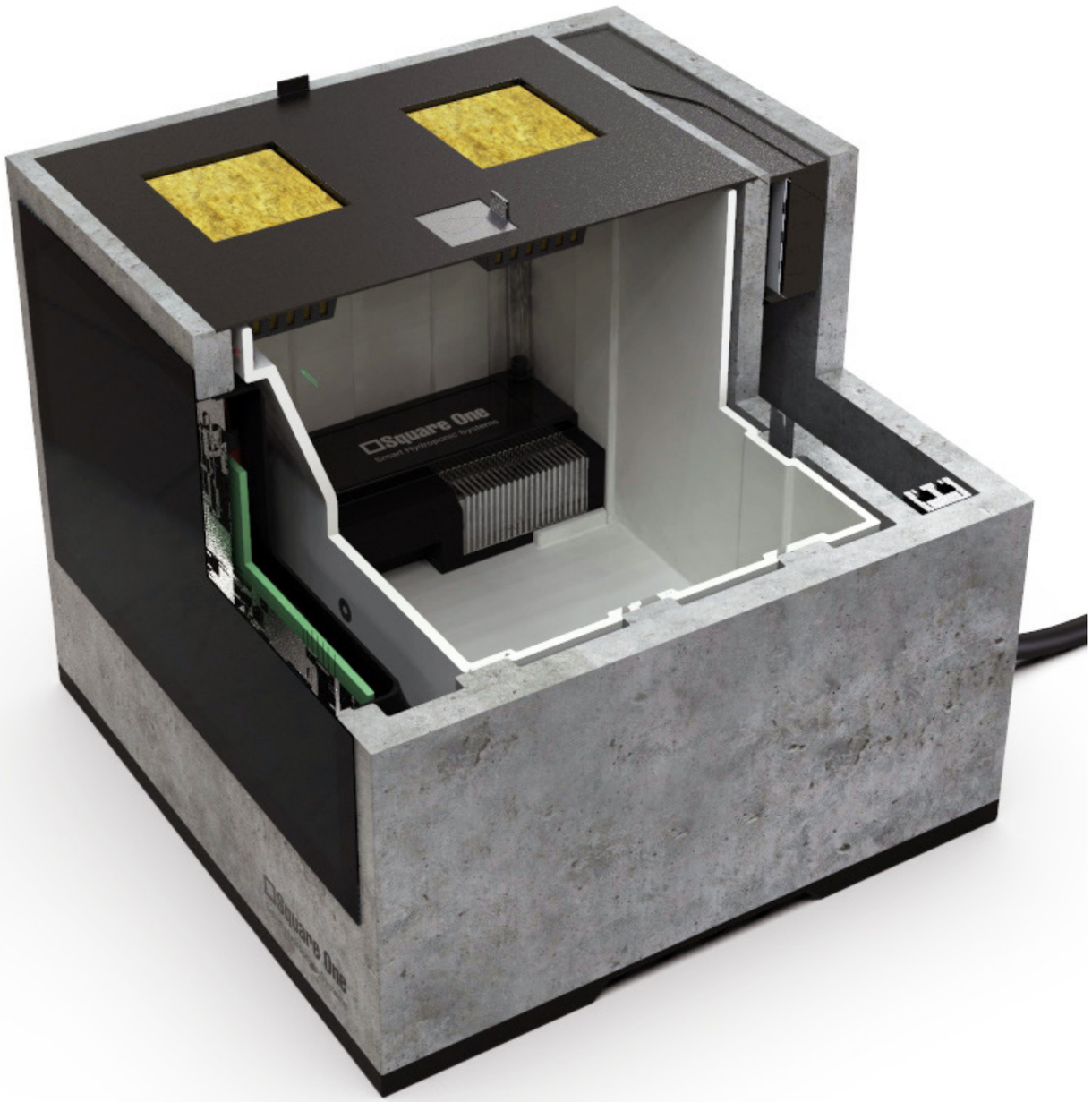
A user can select from hundreds of media blocks with pre-set seeds of vegetation to start the hydroponic home garden! Alerts from the system will inform the user when the pants need nutrients or water.

The exclusive characteristics of the product draw ones' attention to the unique combination of materials that help the product 'stand out' from the surroundings. The concrete body reinforced with light yet incredibly strong carbon fibers houses all the components of the autonomous device.



A user-friendly interface supports the user with guidance and usage directions. The digital interface communication is particularly designed to simplify the interaction with the device for beginners.

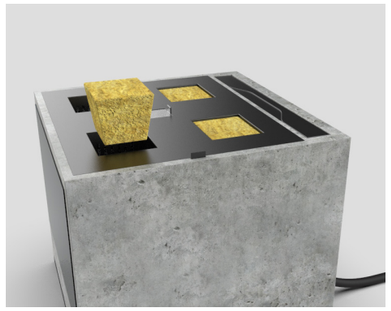
Every component of the SquareOne’s assembly is designed with attention to detail in a way that no compromises are made in terms of reliability and assurance of sturdiness over time. SquareOne products are made from exceptionally high-quality materials ensuring the best performance.



FRESH FOOD IN 3 STEPS!

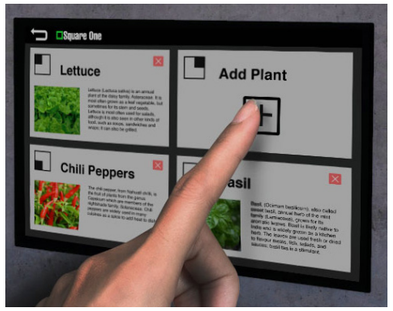
STEP 1

Soak the rockwool media in water for 3 Min and place it inside the open slots on the top of the device



STEP 2

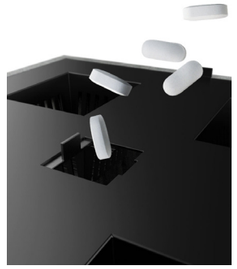
Update the device with the new plant added to the according position on the tray



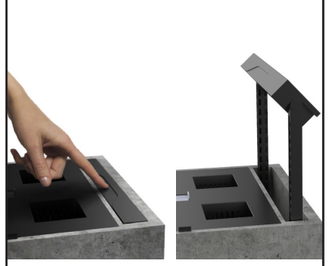
STEP 3

HARVEST!

Add water when the device alerts you



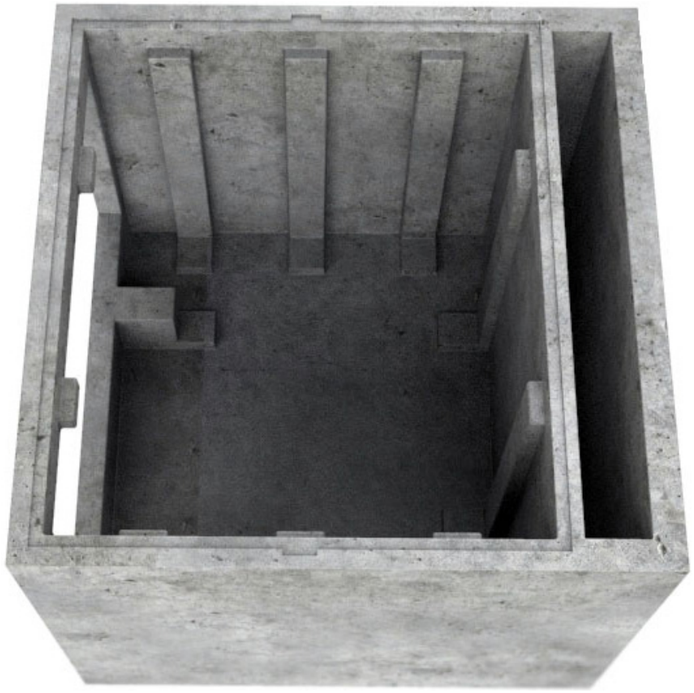
Add nutrients when the device alerts you

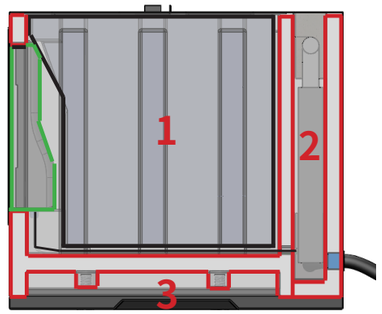


Activate the LED lights when needed

COMPONENTS

MAIN BODY





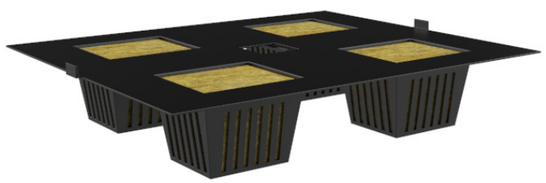
The concrete cast of the main body forms three main sections. The largest section posses structural ribs witch serve not only as means of increasing the strength quality but they also follow specific order to ensure a tight fit of the water container. This section houses all the main electronics, water tank, aluminum tray on top, and PCB case.

The smaller section on the back of the product accommodates the LED light and the electrical transformer.

The smallest section of the body is a 30mm deep cutout with extrusion holes for screws which help secure an additional part on the bottom of the product. The cutout's only purpose is to reduce excess material and therefore following a reduction of the overall weight. The slightly increased water and concrete ratios of the concrete mixture in the tests showed an extremely high density of the material therefore also affecting the weight.
This cutout reduces the overall mass of the concrete body by about 7%.

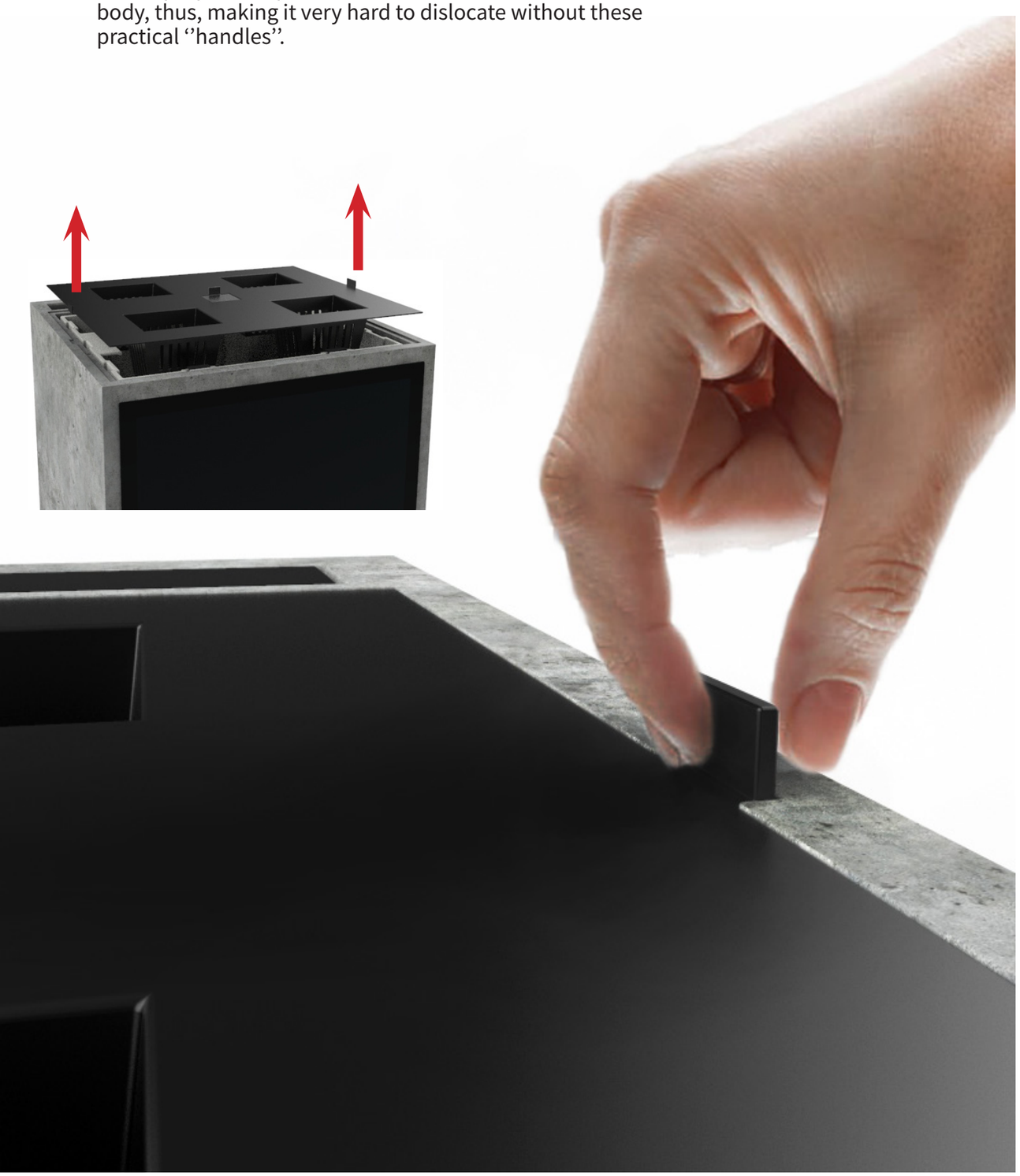
TRAY

A metal tray lays on top of the concrete body in a shallow cutout which is closely surrounded by the concrete. This proximity creates the visual contrast of these two materials, which I initially aimed to emphasize upon.

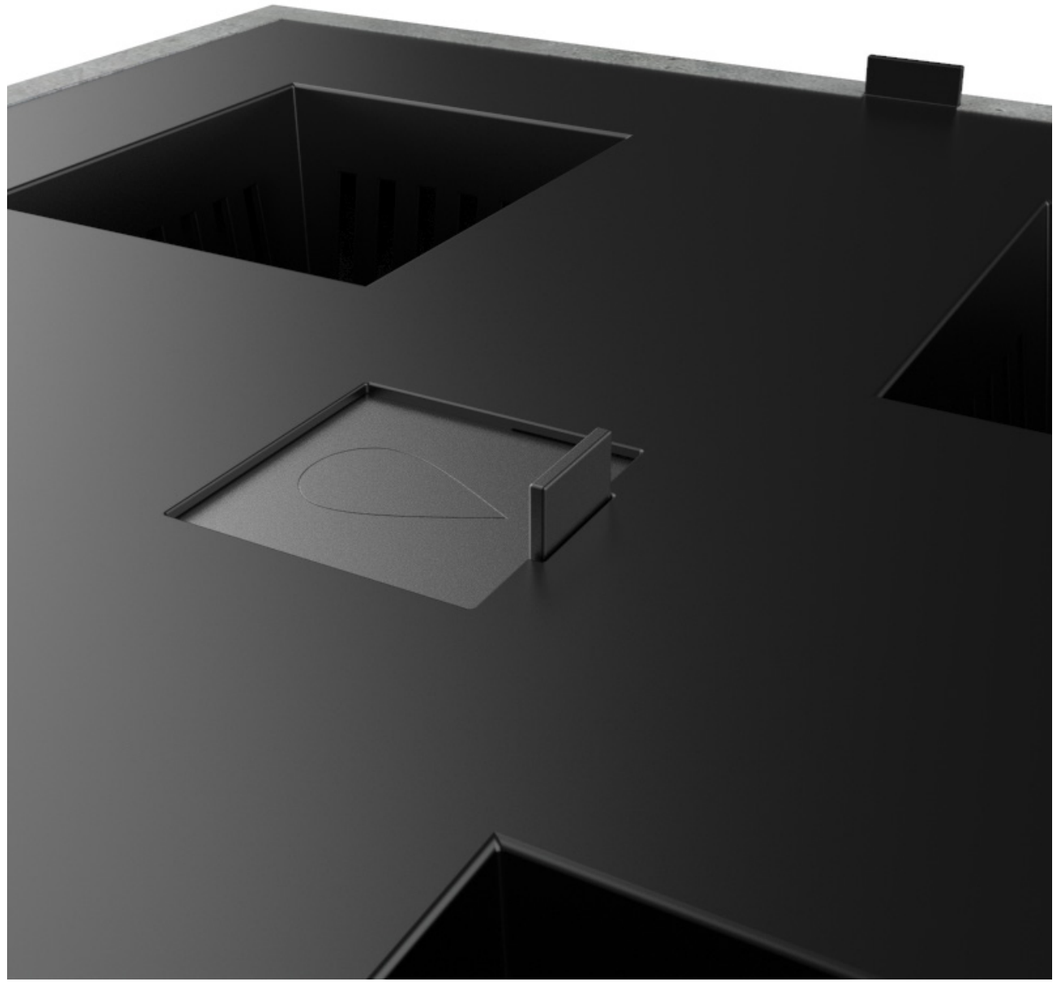


The media blocks will be provided along with the purchase of the device with pre-set seeds inside the media, with a variety of options. Small pockets inside the media will contain the seeds and when water is added the seeds will immediately enter the first germination phase.
Media and seeds will be able to be purchased from the brand without the involvement of a 3rd party. That way, one should not make any additional purchases of seeds or media. Of course, media blocks without pre-set seeds inside them will also be available as some users might want to grow exotic plants of their choice.

Equal extrusions of 90 degrees on both sides of the tray add the convenience of having a grip area when the tray has to be lifted. The tray lays closely fitted in the cutout surface to the concrete body, thus, making it very hard to dislocate without these practical ‘’handles’’.



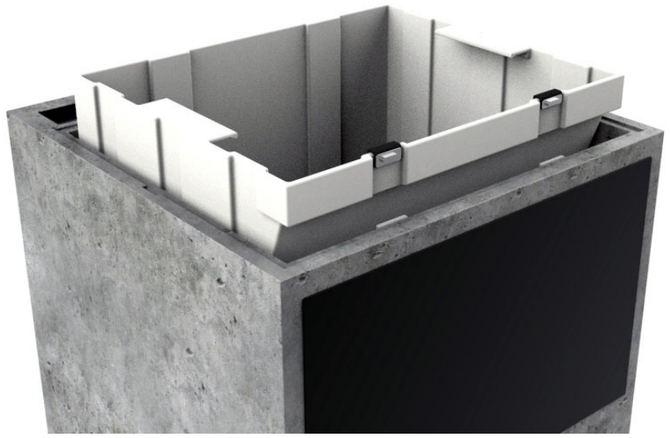
Corresponding design language and elements are used for the refinement cover.
At the center of the tray is located the refinement cover. The cover has the same material and finishes as the rest of the surroundings. However, the color is slightly contrasting as means of communication of an interaction. On the top surface is engraved a drop icon suggesting the purpose for which is to be used.



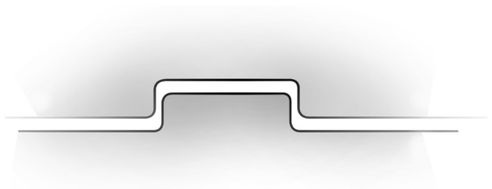
This small cover is held by a rail-like extension under the tray surface. Hence, the cover can slide open by the 90 deg extrusion at the edge. This is where water and nutrients can be provided from.

The brand will also provide nutrients in the form of tablets, as they offer a much more practical solution for precisely dosing the required value than current liquid fertilizers.

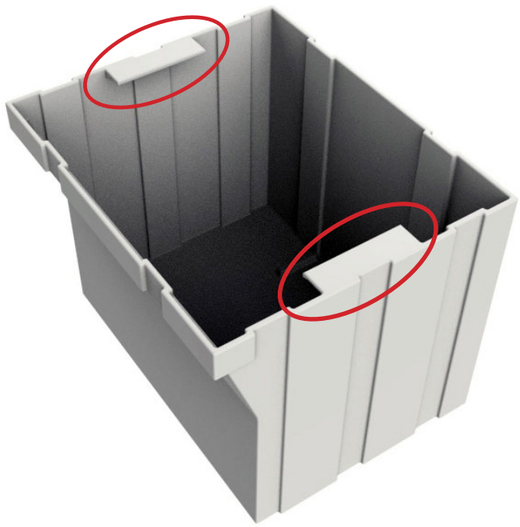
WATER CONTAINER



The water container follows the same design shape of the ribs of the main body. As the container is being surrounded by the structural ribs it fits closely to the walls of the body and the ribs securely hold the container in place reducing the chance water spillage. It must be mentioned a minimal spacing is left between the surfaces as shrinkage and/or expansion of the plastic material is possible with time.



The gap between the surfaces



When the water container has to be emptied and taken out of the device, two horizontal extrusions act as handles for the user to hold on to.

Under the concrete body is attached a part that fits in the smallest cutout of the main body. The rubber part protects the surface on which the device will be put on. The hard rubber material will prevent the edges of the concrete to leave any scratches and marks on the surface bellow. When the device has to be relocated, two carefully projected cutouts on the sides assist the user to slide their fingers underneath the product for ergonomic support.

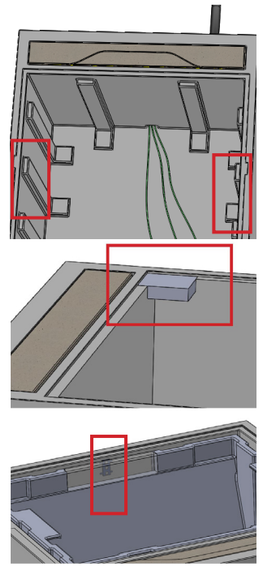
Four steel screws fix the part onto the extrusion holes of the main body.

SIDE VIEW

SENSORS

Two sensors measure and communicate the water level, temperature, and nutritional value. They are ‘clipped’ on the edge of the water container as they constructed around the wall thickness of the container. I found this technique of securing the sensors to be superior to other ideas I previously had of the positioning of the sensors on the sides of the container, from a transparent piece, and horizontally to the edge of the container.

Previous concepts

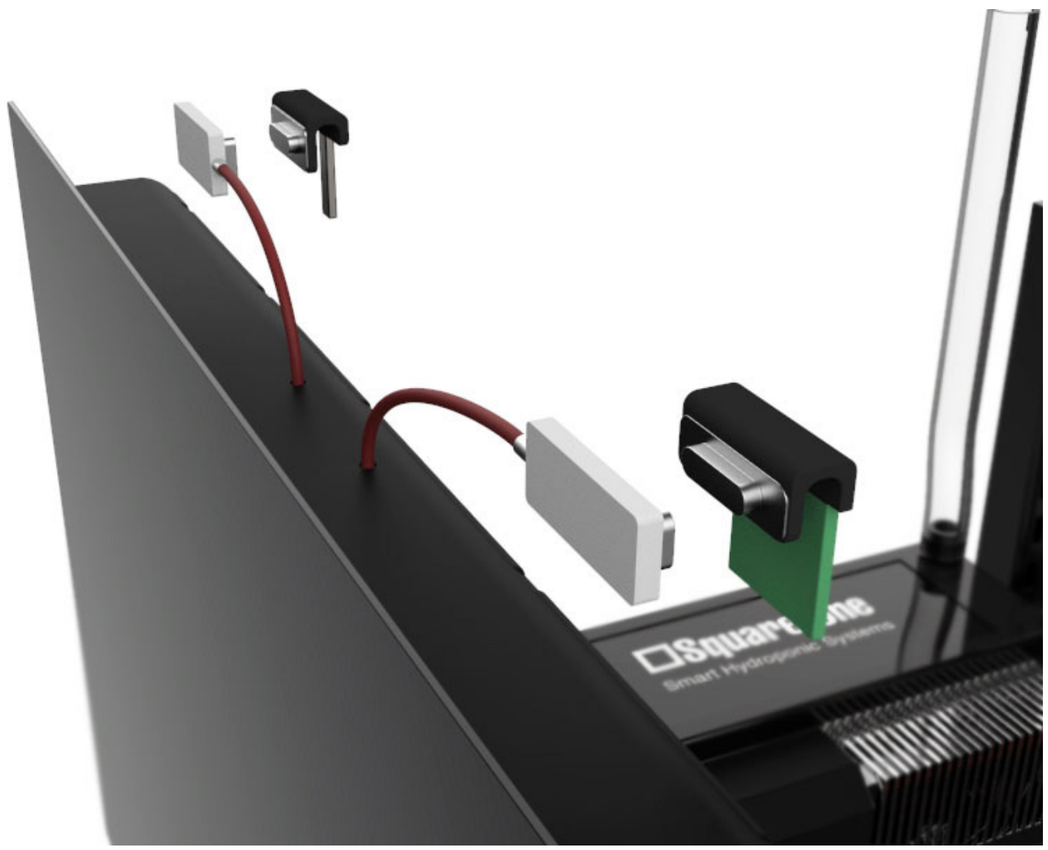


The sensors are connected to the PCB board with a magnetic connection, similar to the charging connectors of ‘‘Apple’’.
The reason why the final concept ended up with these magnetic connectors is due to an initial concern I had with the fragility of wires. The wires could be easily torn if one lifts the water container before disconnecting them from the sensors as they are all connected to the control circuit.

With the magnetic link, the sensors are easy to disconnect and even if the user forgets to remove them before removing the water container the sensors will just disconnect, and they can be simply reconnected afterward. This also makes their replacement very simple instead of replacing the whole electrical module.

Water level sensor

Thermometer and Nutritional value sensor



LIGHT

The light is stored inside the back compartment of the body.
With the help of a sliding spring-loaded mechanism, the light can expand and support the plants with an additional light source.
This feature provides the user with the ability to compress the light back in the compartment if the plants get enough natural sunlight.

A small dent on the top surface of the light suggests an (push) action to the user in order to activate the mechanism and to ‘open’ the light.

The light itself is equipped with low voltage LEDs with red, white, and blue diodes. The spectrums of illumination of the red, white, and blue diodes are well known for their high efficiency in hydroponics.

Hinges of both sides allow rotation of the head at 90°. This feature allows accurate control over the flow of light facing the plants, as some seedlings require more light in the early germination stage.

The mechanism resembles sliding door gears and it works on a similar principle. However, the challenge with light mechanism was the vertical positioning of the light's components and therefore gravitational obstruction of the mechanism to work in the same way as a ‘‘sliding door gears’’ mechanism. Two closely fitted aluminum extrusions slide up and down with the help of a spring-loaded mechanism of two ‘rollers’. One of the extrusions has different sections of thickens, therefore when the rollers press against the surface they stop at a certain section and lock holding the light at a certain height.

DISPLAY AND CASING

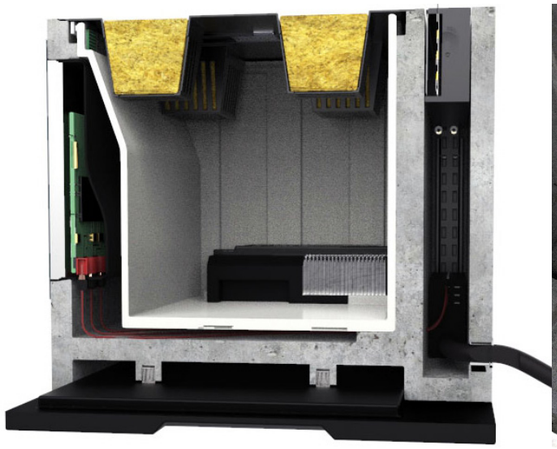
Stationed firmly to the back of the monitor is the control PCB board. The sensitive electrical board is protected by a plastic case that securely connects with a ‘lip and groove’ feature to the back of the display (right image). This plastic case protects the electronic board from water splashes and leakage.
Wires travel from and to the PCB board through openings on the bottom and the top of the casing going above and underneath the water container.

ELECTRIFICATION

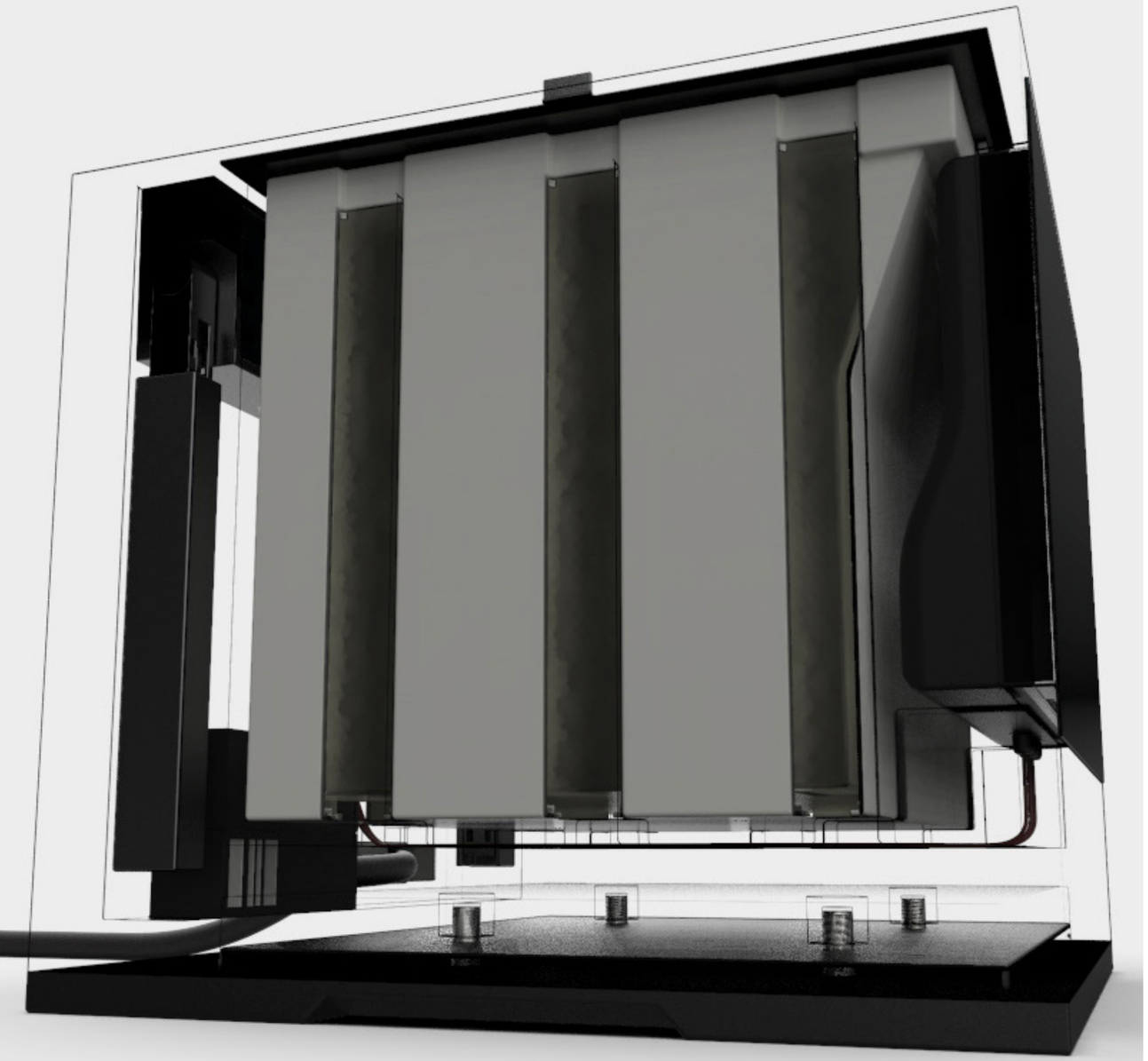
Although designing the electrification and cable arrangement wasn’t a priority in the design process. I believe it is an important bit that brings a note of realism to the concept. After every new feature and update which was made on the concept, the cable arrangement had to also follow the changes.

Parts of the device were designed in a way to specifically accommodate and ensure enough space for the cable passage. A distinct feature in the design is the small 10mm gap between the water container and the main body. The ribs of the concrete body raise the container just enough for the cables to pass through a small opening reaching the transformer in the next section of the main body.

Section view

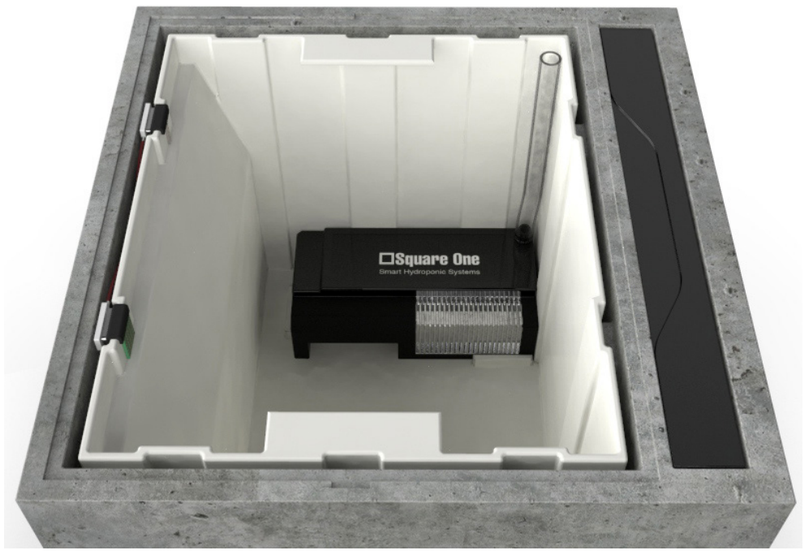


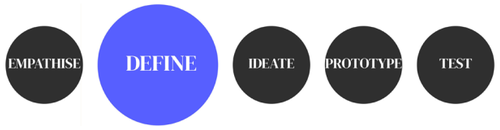
Wires traveling through the gap between the water container and the main body (refer to the next page).



AIR PUMP

At the bottom of the water container is attached the air pump. The pump not only circulates the water inside the container but more importantly it provides the roots with the needed oxygen levels. The pump is an autonomous part of the device which is fixed to the bottom of the container with three short walls surrounding the body of the pump.





USER INVOLVEMENT

The user’s involvement will consist three major activities. For all of those three actions the user will be informed by either the interactive display or the brand’s app.

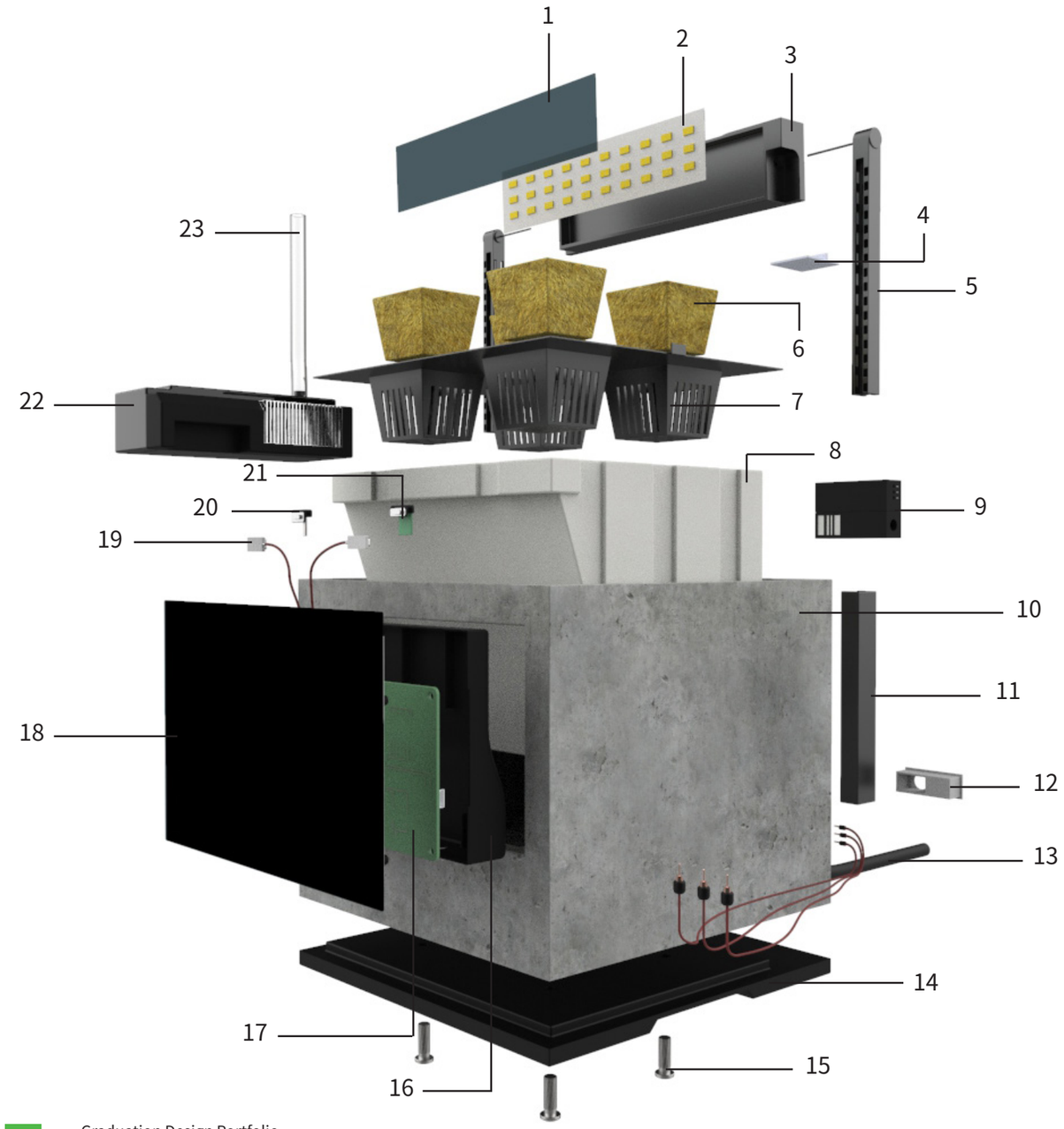
Water top-up will be the most frequent operation that will occur to be done, especially when the plants mature the water levels will start to drop faster than usual and requiring more frequent top-ups.

Nutrient provision will be done with the dissolvable tables provided by the brand. The tablets will contain substances of a general fertilizer.

Water change would be done every six to nine months. Unlike most basic hydroponics, ‘‘SquareOne’’ devices are equipped with an air pump that constantly circulates the water inside the container, which also enriches the solution with oxygen. Therefore, water change can be done at longer intervals, compared to the 3-4 months period of traditional systems.

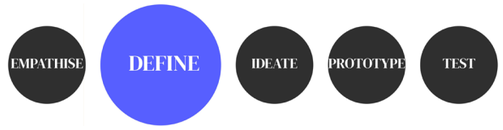
MANUFACTURING PROCESSES & MATERIALS

1. Light Diffuser
2. LEDs
3. Light Housing
4. Refillment Cap
5. Supporting Rods
6. Growing Media & Seeds
7. Tray
8. Water Container
9. Transformer
10. Main Body
11. Arms Extrusions
12. Cord Exit Component & Reset Button
13. Power Cord
14. Bottom Part
15. Steel screws
16. PCB Protective Case
17. PCB Control Board
18. Display
19. Magnetic Connectors
20. Thermometer & Nutritional value Sensor
21. Water Level Sensor
22. Air Pump
23. Air tube



COMPONENT	MATERIAL	MANUFACTURING METHOD
1. Light Diffuser	Acrylic (lightly shaded)	Injection Moulding
2. LEDs	N/A	N/A
3. Light Housing	Anodized Aluminum	Die Casting
4. Supporting Rods	Anodized Aluminum	Extrusion
5. Refillment Cap	Anodized Aluminum	Die Casting
6. Growing Media	Rockwool	Spinning of Slag and Basalt
7. Tray	Anodized Aluminum	Stamping and/or Die Casting
8. Water Container	Polypropylene	Injection Moulding
9. Transformer	N/A	N/A
10. Main Body	Reinforced Concrete	Casting
11. Arms Extrusion	Anodized Aluminum	Extrusion
12. Cord Exit Component & Reset Button	Polypropylene	Injection Moulding
13. Power Cord	N/A	Stranding
14. Bottom Part	Natural Rubber	Molding
15. Screws	Stainless Steel	Thread Rolling
16. PCB Protective Case	Polypropylene	Injection Moulding
17. PCB Control Board	N/A	N/A
18. Display	N/A	N/A
19. Magnetic Connectors	N/A	N/A
20. Thermometer and Nutritional value Sensor	N/A	N/A
21. Water Level Sensor	N/A	N/A
22. Air Pump	N/A	N/A
23. Air Tube	N/A	N/A

COMPONENT	COLOUR	FINISH
1. Light Diffuser	N/A	N/A
2. LEDs	N/A	N/A
3. Light Housing	Dark Grey #242121	Sandblasted (F800)
4. Supporting Rods	Dark Grey #242121	Sandblasted (F800)
5. Refillment Cap	Metalic Natural #595555	Sandblasted (F800)
6. Growing Media	N/A	N/A
7. Tray	Dark Grey #242121	Sandblasted (F800)
8. Water Container	White #f5f5f5	Smooth (none reflective)
9. Transformer	N/A	N/A
10. Main Body	R:204B:202G:202 #cccaca	Smooth outer surfaces
11. Arms Extrusion	Dark Grey #242121	Sandblasted (F800)
12. Cord Exit Component & Reset Button	N/A	N/A
13. Power Cord	N/A	N/A
14. Bottom Part	Black	Natural Rubber
15. Screws	N/A	N/A
16. PCB Protective Case	Dark Grey #212121	Smooth (none reflective)
17. PCB Control Board	N/A	N/A
18. Display	N/A	N/A
19. Magnetic Connectors	N/A	N/A
20. Thermometer and Nutritional value Sensor	N/A	N/A
21. Water Level Sensor	N/A	N/A
22. Air Pump	N/A	N/A
23. Air Tube	N/A	N/A



During the evaluation process in the labs, I also managed to evaluate how different concrete ratios can affect the colour and texture properties of a cast.


Img.108 Black polished

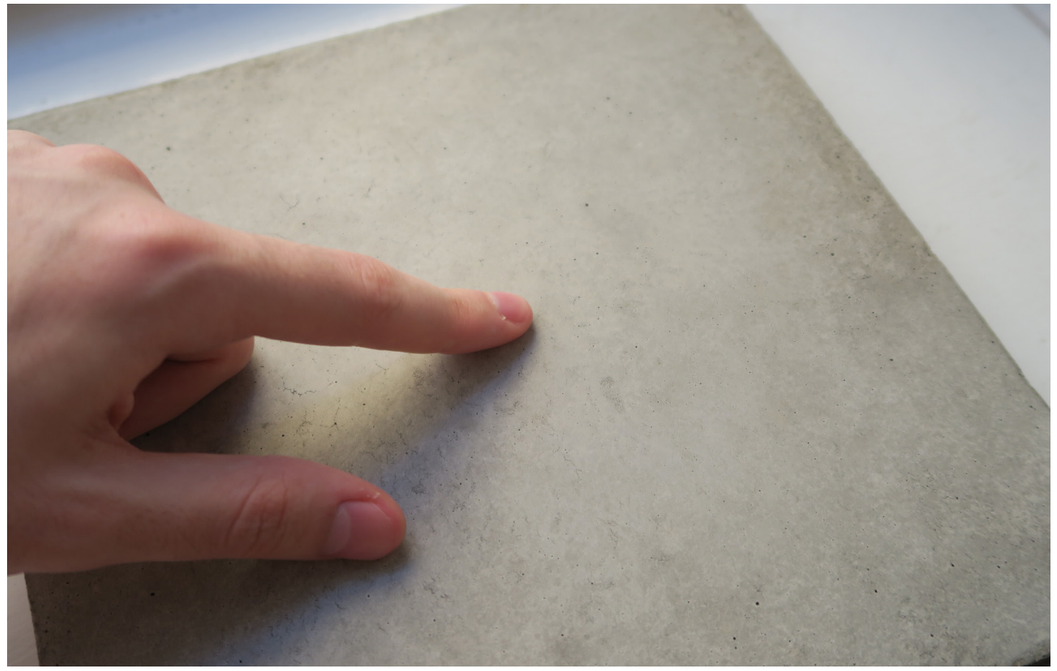

Img.109 Fosil pre-cast


Img.110 Gray polished


Img.111 Basalt polished

I aimed to attain a light grey colour with a smooth/glossy finish. Before the university closure, I managed to cast a single panel with dimensions very close to the final product, which gave me an idea of the definitive texture. In mixture for the panel, the concrete ratio was slightly increased in order to reach the smooth glossy texture.

Img.112 200x200mm cast



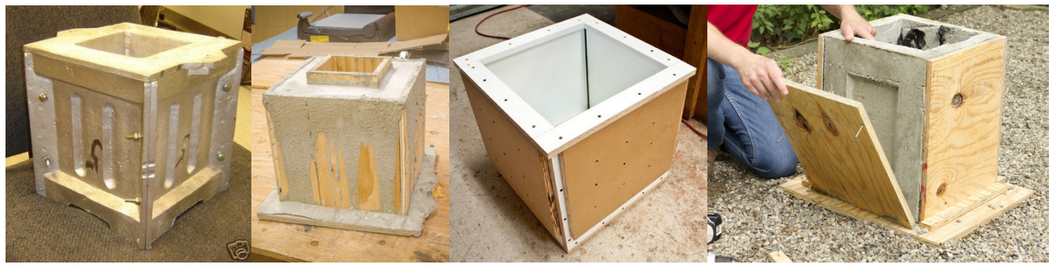
Img.113 Carbon Fibres

The weight and durability of the product is an essential aspect of the design of the device. Hence, from the tests and discussions with the experts, I decided to reinforce the concrete mixture with carbon fibers instead of steel. Carbon is almost 10 times stronger than steel and about 5 times lighter.

The main body will be cast in one piece in a coated birch plywood mould. The birch plywood has smooth surfaces and this will help to dismantle the mold easily without damaging the concrete. After the body has cured it will then be submerged in water for 20 to 28 days. Sumbmuring concrete in water has proven to harden the material and to also reduce the chance of cracking occurring.

Water sealing resin will not be needed, despite my initial concerns of leakage. The staff at the Hammer workshop ensured me that a water leakage of a concrete cast with a ration of ingredients of the cast I made, would be almost impossible. Therefore, sealing resin won't be necessary, especially when the body is cast in one piece.

Img.114-117 DIY Concrete Moulds

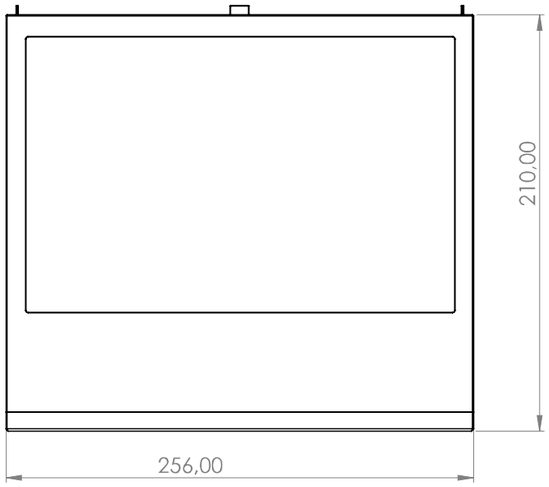


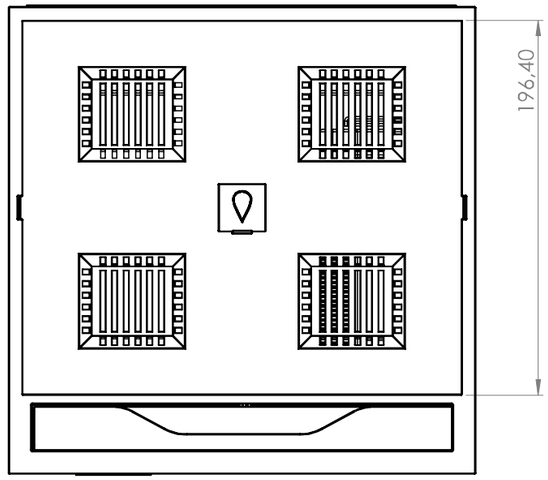
MAINTENANCE

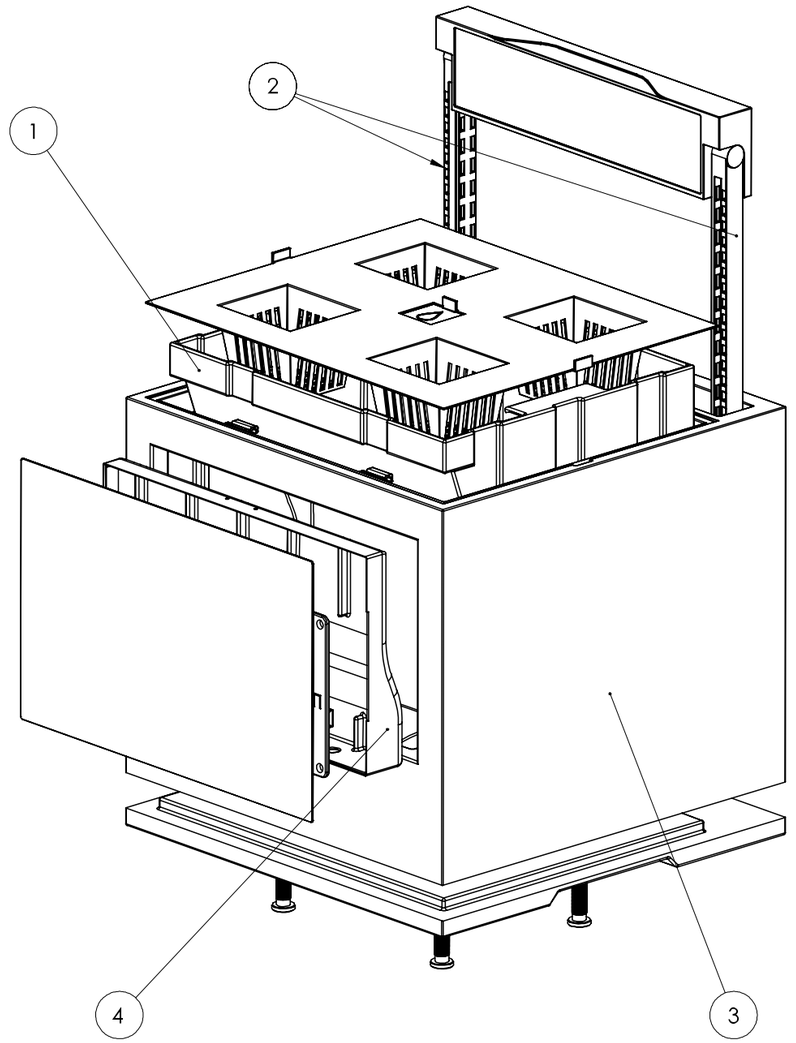
Despite the fact that the product is designed to be made from high-grade materials guaranteeing a long life span, maintenance, and performance duties must still be carried out.

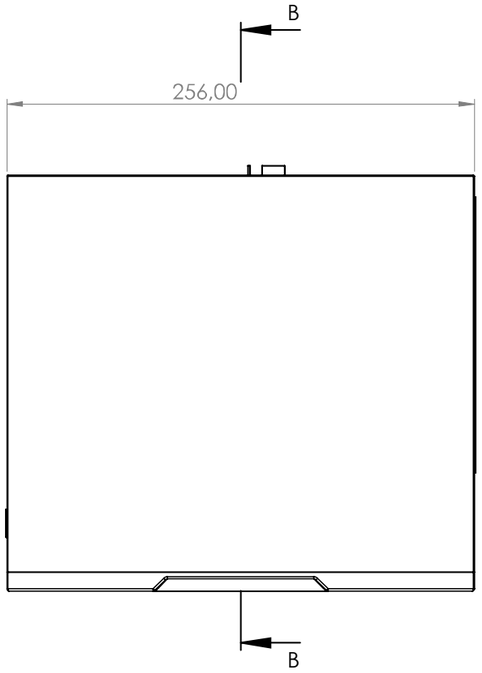
Software upgrades and interface updates will not be a concern for the user, as the device is connected to a local network. System checks and updates will be done automatically.

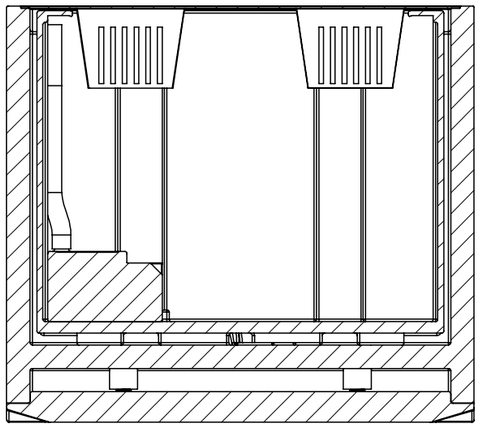
General cleaning maintenance of the main components, however, would be recommended. The water container is particularly recommended to be sanitised every 6 to 9 months, reducing the chance of developing mycobacteria.





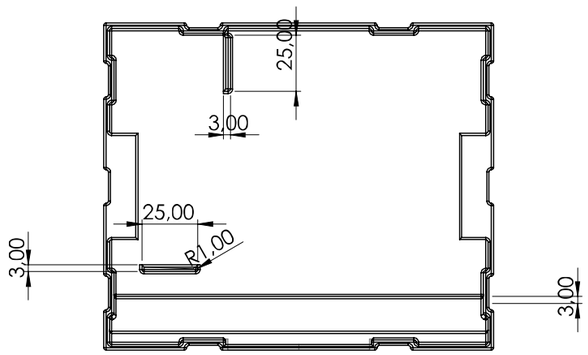


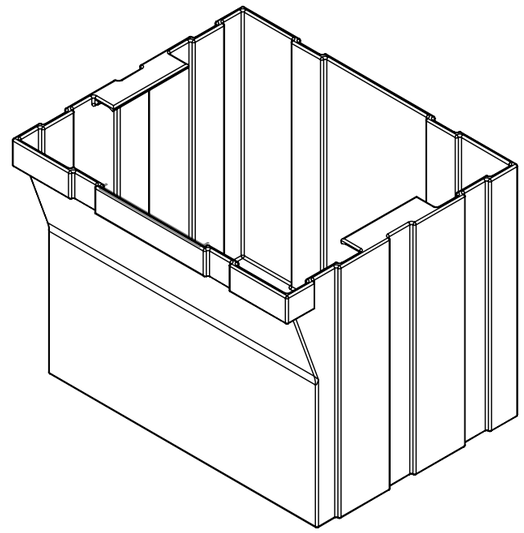


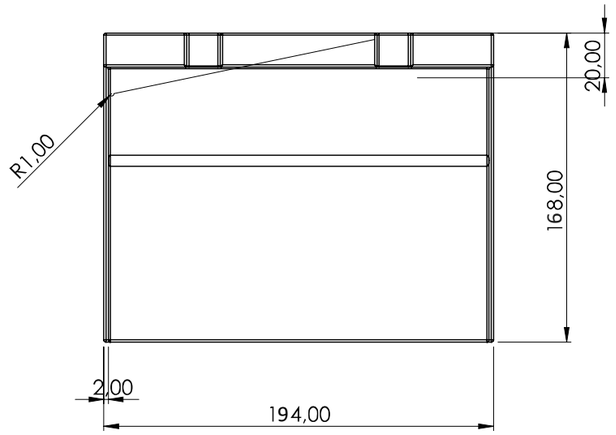


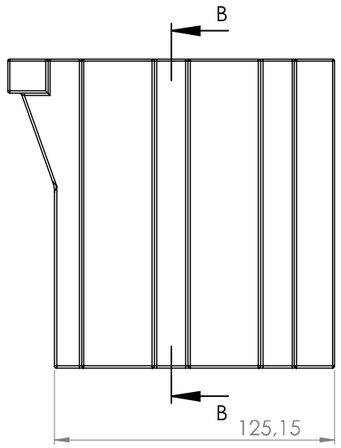
SECTION B-B

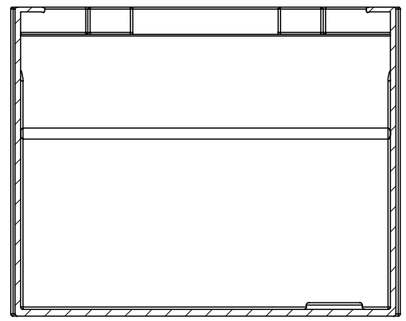
UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: TOLERANCES: LINEAR: ANGULAR:			FINISH:			DEBURR AND BREAK SHARP EDGES	DO NOT SCALE DRAWING	REVISION
#	NAME	NUMBER						
1	water container	1					TITLE:	
2	Extrusion rods	2						
3	Main Body	1						
4	PCB Case	1						
				MATERIAL:			DWG NO. Assembly.SLDASM	A2
				WEIGHT:			SCALE:1:2	SHEET 2 OF 2



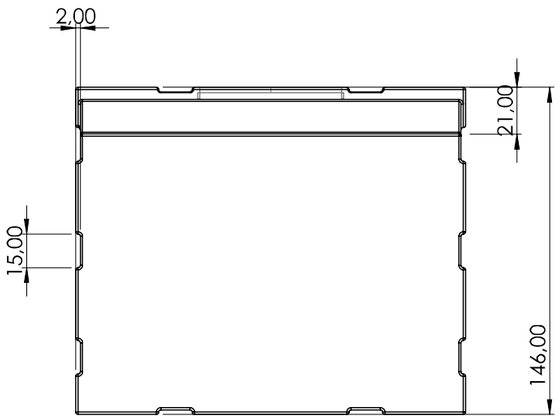








SECTION B-B



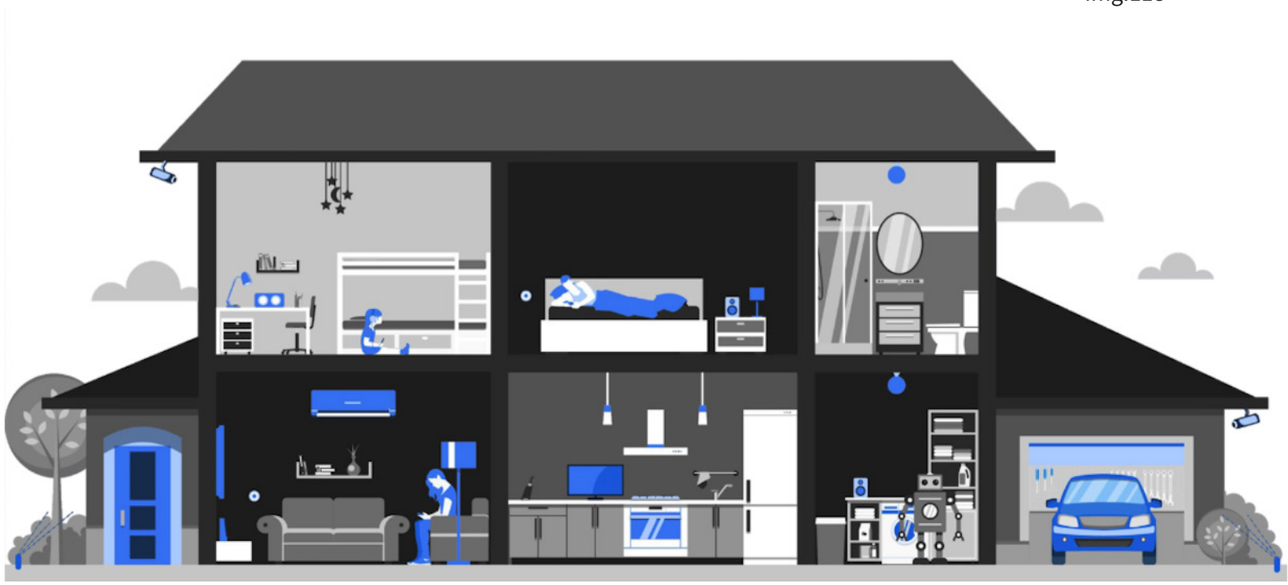
UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: TOLERANCES: LINEAR: ANGULAR:		FINISH:				DEBURR AND BREAK SHARP EDGES	DO NOT SCALE DRAWING	REVISION
	NAME	SIGNATURE	DATE					
DRAWN							TITLE: Water Container	
CHK'D								
APPV'D								
MFG								
Q.A				MATERIAL: Polypropylene (PP)			DWG NO. Water container. sldprt	A2
				WEIGHT:			SCALE:1:2	SHEET 1 OF 1

DIGITALISATION AND THE ROLE OF DESIGN

INTERNET OF THINGS

Internet of things is undeniably becoming more and more noticeable in everyday life. The data shared by the devices in our everyday life make our lives not only easier on a surface level of user experience but it also helps us understand human behavior and shows us certain repeatable patterns. Ultimately, this provides us with opportunities for improving and enchasing all areas of life. In order for a long-lasting product to be competitive on the market, it must meet the technological standards of the future. The widespread of IoT around the world in various industries is a sign of change that companies must consider and at some stage even adapt to.
Looking into the future, I believe thinking ahead in time and taking the right step of a change in an essential part of the future designers' approach.

Img.118

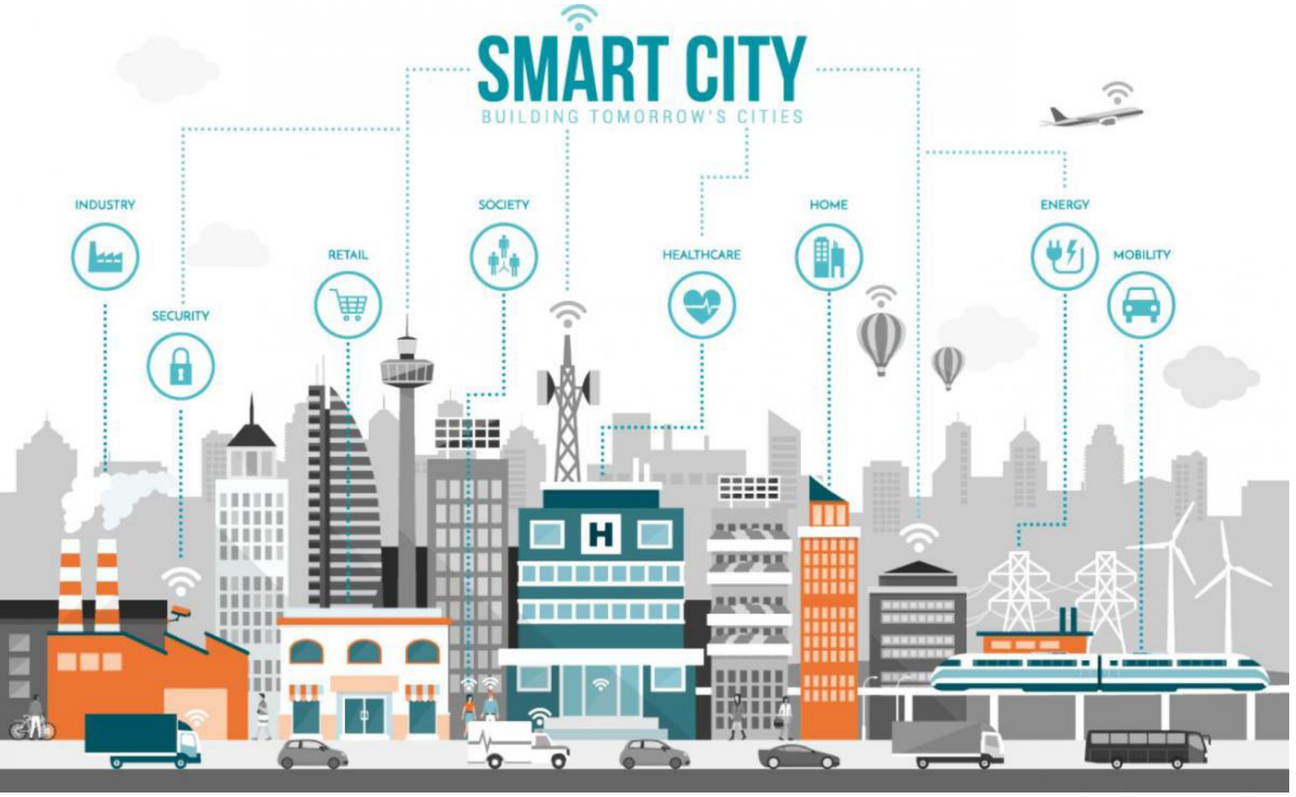


A global and local food production efficiency will drastically increase if a form of automation is being slowly implemented into the production process.

A step into digitalisation of the agricultural process will also inevitably reduce human effort, greenhouse gas emissions, water waste, and more.

In addition, due to the automated nature of the process, the productivity and efficiency levels will be as high as we have ever seen before. Jobs such as data analysts and software operators will be on high demand, assuming the systems are being implemented worldwide.

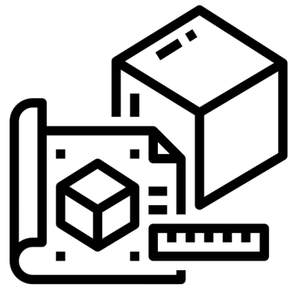
Img.119



Because of the projects' essence, I considered every aspect from manufacturing, materials, market, environment, users, as well as interface design and user experience. A vital key element of the hydroponic device's success is the user communication design which almost entirely is done through an electronic device and a display. Nevertheless, the device is still containing the element of emotional connection relying on the user of physically taking care of the high tech gadget through watering and nutrient provision.

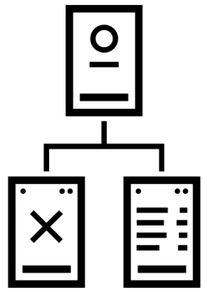
And this is the reason why my design process is looking at both industrial and UX/UI design prospects.

Product/Industrial Design



Functional
Aesthetical
Emotional

Communication, UX, UI Design



Ease of use
Accessible
User interface

BRAND IDENTITY

Logo and Elements

SqareOne is a concept for the very near future, with the goal of changing the production of fresh food at home with the help of technology. The brand's name 'SqareOne' symbolises the fundamental first step of entering into a new era for homegrown food. Additionally, the word 'Square' and the logo next to it represent the square-shaped product of the series.

Square One

Smart Hydroponic Systems

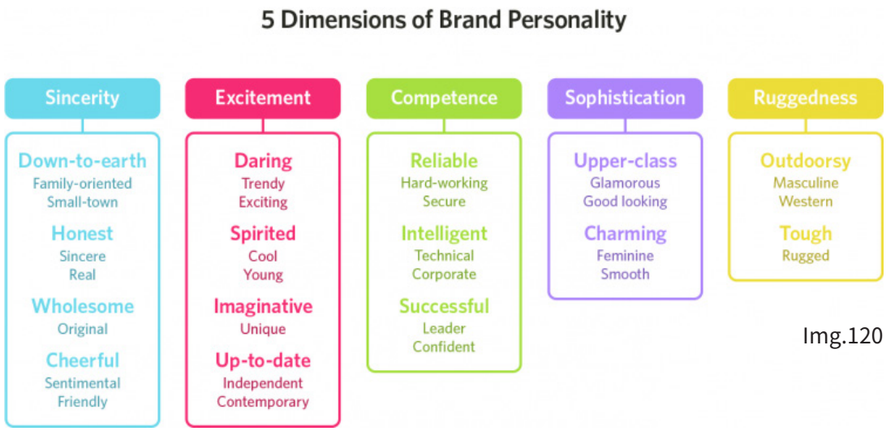
Square One

Smart Hydroponic Systems

EMPATHISE DEFINE IDEATE PROTOTYPE TEST

Colour

Colours have a strong emotional impact on people and they can also often affect decision making in customers. SquareOne's colour pallet reflects on the brand personality and message of promoting health and reliability. The green colour attributes are preserved from implications such as nature, health, growth and prosperity. Pastel shadows of grey adopted in the brand colour bundle stand as contrasting shades to the principal green colour.



Img.120

'Square One' colour palette

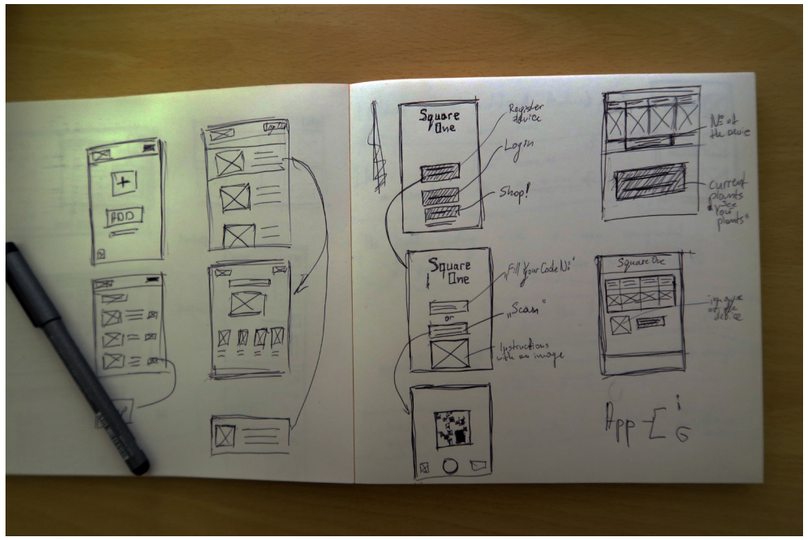
#e8f0e6
R: 233
G: 240
B: 231

#060505
R:6
G:5
B:6

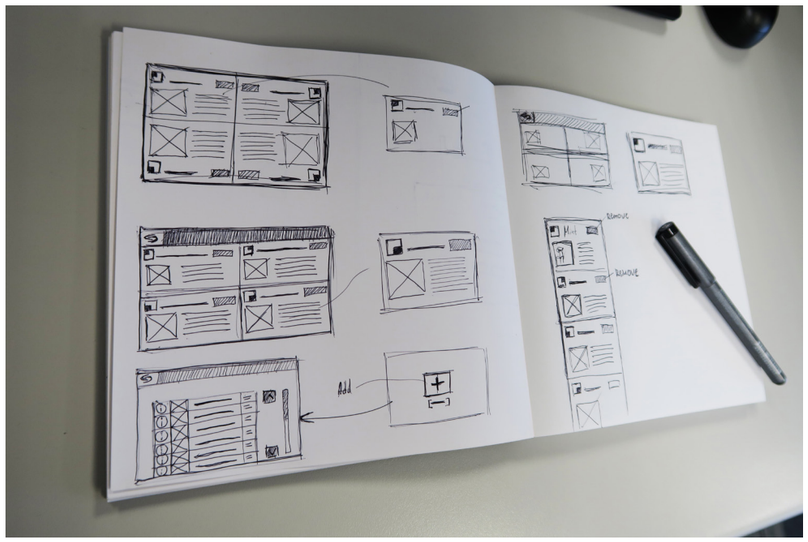
#4fb848
R: 79
G: 184
B: 72

#231f20
R:35
G:31
B:32

The two ways of communication of the product will be with the screen display and the bran's app. For this reason, I began developing both interfaces as separate projects since they require different approaches.



Img.121 App's wireframe



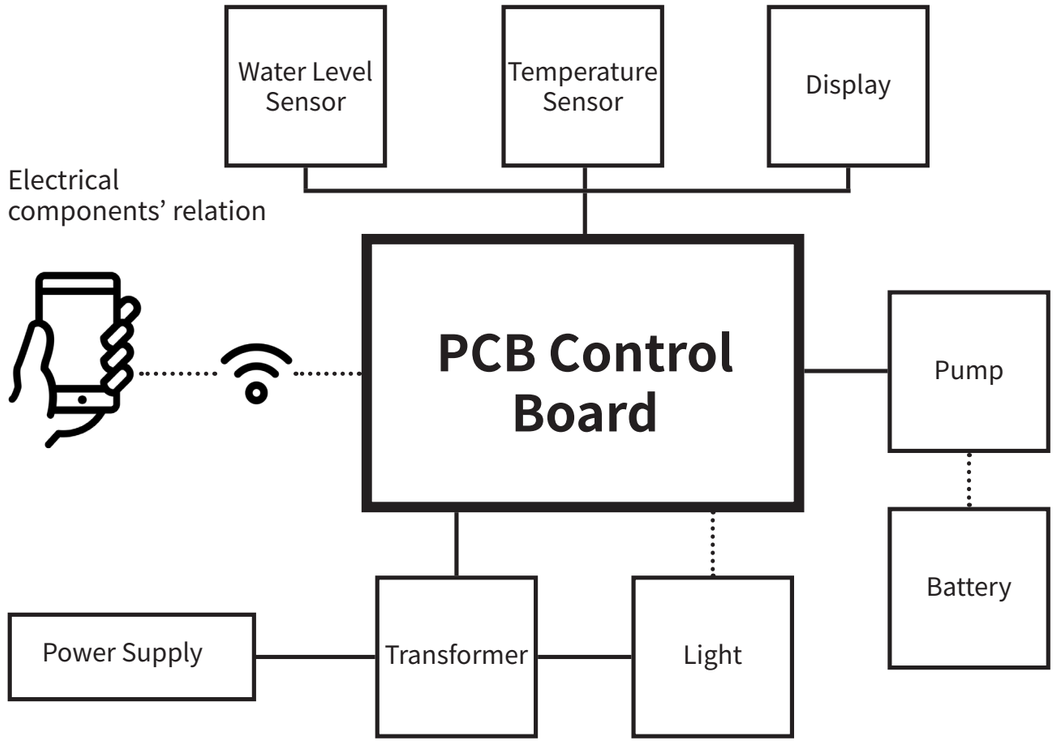
Img.122 Dispay Interface mockups

To create a realistic experience of digital interaction with the interface I trough of using Raspberry Pi and a touchscreen display on the final model. Unfortunately, I was advised in tutorial discussions to develop further only conceptual images of the interface. As at this time it became very certain that completion of a final model wouldn't be possible.

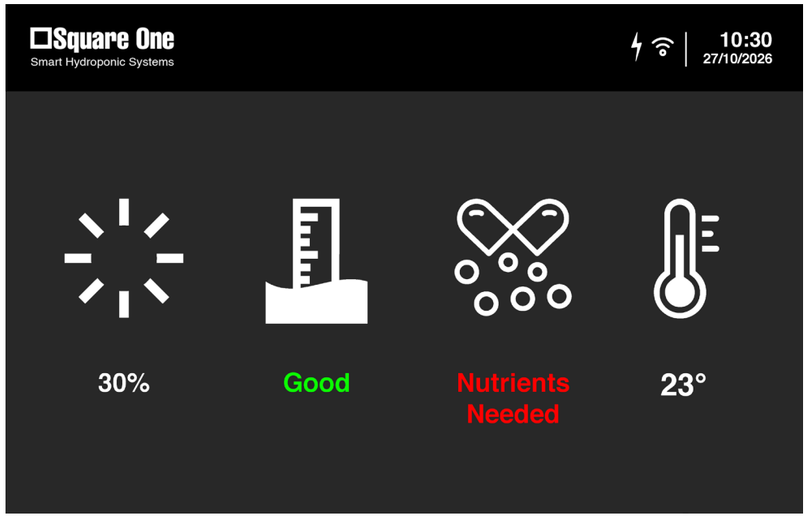
The diagram below shows all the electrical and supply components in connection to the PCB board in the final model.

Img.123,124 Interface prototype tests

Electrical components' relation



DISPLAY'S INTERFACE

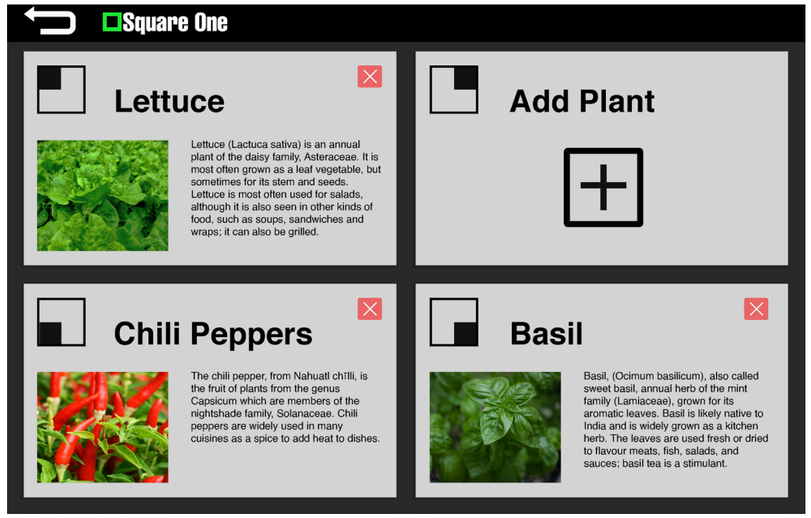


Img.125,126 General Information Window

This is the first frame of the product's display. This screen will always pop first on the display if either the screen has been touched once from a sleep/standby mode or if there is an active alert (as it is showing on the display above, that nutrients are needed).
There are four elements on the screen constantly displaying information.
1. Light intensity
2. Water levels
3. Nutrient levels
4. Water temperature

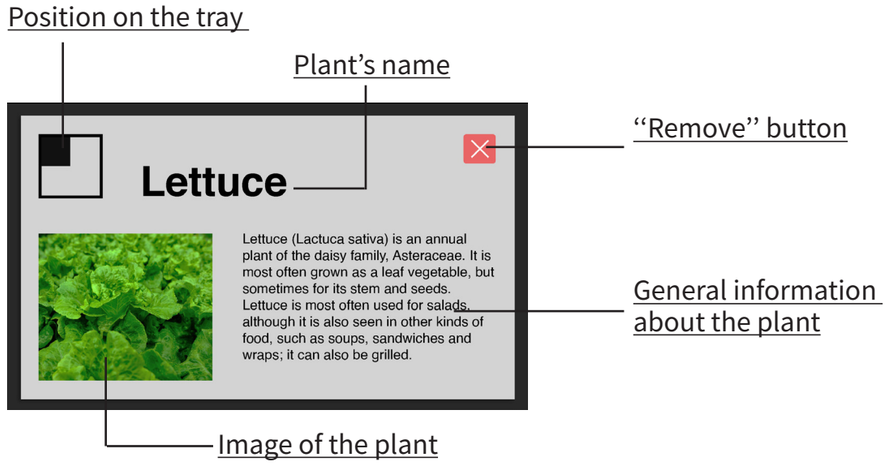
The main screen is designed in a way in which information is displayed only with icons. The reason being was to keep it as much ''language mutual'' as it can be, in order to be understood from the first sight, and providing all the important information.

EMPATHISE DEFINE IDEATE PROTOTYPE TEST



Img.127,128 Informative Control Panel

This second screen is only concerning the information on the current plants and vegetation in the device. This panel also, however, allows access to update the system and also remove plants.
Each section is positioned accordingly to the position of the tray. The black squared element on the top left corner of each section tells the user where on the tray a particular plant is positioned.
New plants can be set in any order as this pannel provides only information on the arrangement and basic information for inexperienced users.



A way of managing the device/s and receiving alerts of action away from home will be though the ‘Square One app’.

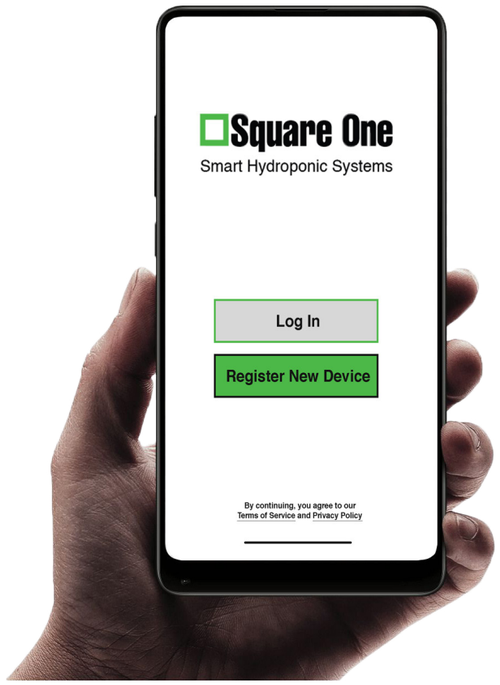
Every device comes with a Personal Identification Number consisting of eight characters which can be located on the back of the product. In addition to the ID number, there’s also, a QR code that can be scanned easily with a phone’s camera.
All devices one owns can be registered on the platform and managed from within the app.

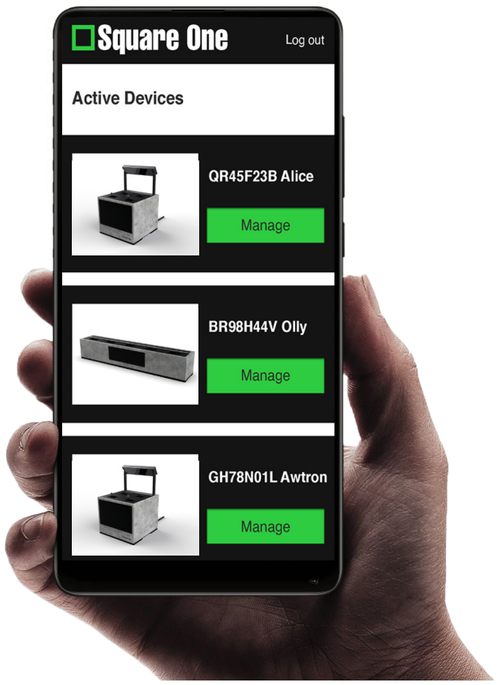
The app only acts as an additional way of connection and control. However, the device can be controlled from its own display and the app is not an essential feature but just an addition.

The app could be particularly useful for users with several products of the brand (Like small restaurants and business) as an easy maintenance tool.

Img.129 Product’s identification number and QR code

Img.130,131 Brand’s app





FINANTIAL POINT & INVESTMENT OF URBAN FARMS

Square One is by no means a cheap product, but it is designed in a way to ensure it lasts long and performs better than anything else of the current market! Every aspect of the product such as materials selection, sustainability, accessibility, ease of use, and the latest technologies are incorporated to serve the user and ensure outstanding performance.

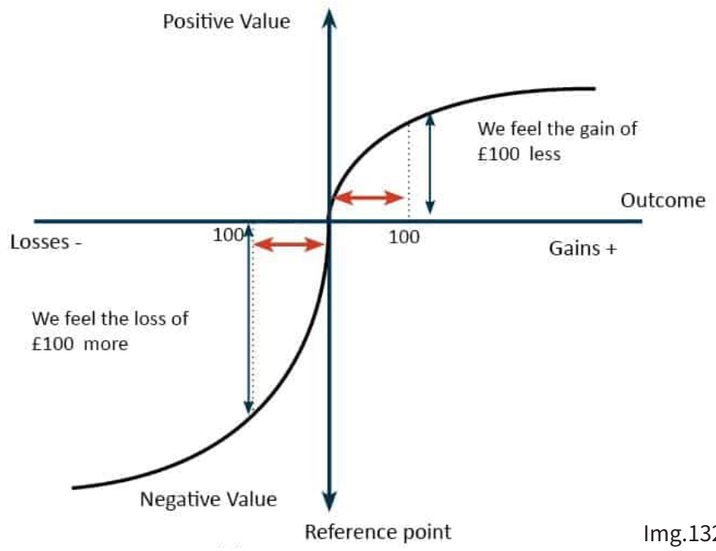
Hydroponics are extremely water efficient and require a minimum amount of water, which makes the process a lot cheaper on a larger scale. Aeroponics, on the other hand, are showing signs of finding the right direction of achieving the much-needed technology for achieving urban autonomous farming.

The constraint of a fast expansion of commercial urban farms comes from the initial sum of investment for a facility and equipment. High amounts of power and special equipment which isn’t yet mass-manufactured limits entrepreneurs of starting a suchlike business in a non-industrialised region of the world. In the long run, however, the system will be much more profitable than the initial years of introduction. Examples of such companies and ideas have already set the ground for a new generation of technologically advanced food production facilities. Regions with research capacity to support such projects will be perhaps first to pave the way for international commercialisation.

EMPATHISE DEFINE IDEATE PROTOTYPE TEST

PSYCHOLOGICAL EFFECTS OF A CHANGE ON THE PUBLIC

A newly established system has to overcome the human aspect, which usually has a natural resistance to change... ‘‘We know what we have, but we don’t know what we gain’’
In cognitive psychology, this is known as Loss Aversion. People tend to have a stronger emotional reaction if they lose a certain thing compare to the amount of satisfaction they get if they gain that same thing. Or with other words, losing 5$ will feel twice as impactful compare to the emotional euphoria of winning 5$. Replacing current agricultural practices would be more challenging for the public in order to accept a new food production model. One way of introducing new technology to the public is by small commercial devices. Only after public satisfaction has been met, then a global scale production may begin. Nonetheless, it must be mentioned that even if public acceptance is met an implementation of a global transition might take years or even decades.



Img.132 Loss Aversion Diagram

PROJECT REFLECTION

The food production will become a service. The question is how we would want this service to function.

The Internet of Things is becoming more noticeable in more aspects of people’s personal and professional lives. An enormous jump in simple routine tasks which everyone’s use to do without really giving it a thought will be built in a system of convenience. The challenge then will be a matter of adaptation as well as a need for a fundamental and ethical understanding.

SqareOne is a concept created around the conditions of our surroundings and demands. The design looks at both practical and theoretical solutions with traditional design thinking at its core. Throughout the project, the design process follows the exploration of both industrial practices and digital user interaction. All that with a genuine intention to serve the user, first!

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