PRODUCT DESIGN INNOVATION
MA.

PRECISE HOME GROWING SYSTEM

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ABSTRACT

This report contains the Final Major Project of MA Product Design Innovation Degree. With the growing concern surrounding sustainable and healthy lifestyles particularly in urban UK, this project explores how we can encourage more young families into growing their own food. The project is split into three key sections, including research, ideation and development, and delivery of the outcome. Research insights led the project to develop to include precision agriculture and sequential farming techniques to prove to the user that it is easy to grow your own food and you do not need to be a gardening expert to be successful. The research led process, led to the design of HelloSprout that allows families to produce sustainable and nutritious microgreens reliably every day of the week using ‘smart’ technology. The introduction into home growing will hopefully persuade supermarket reliant parents to convert and up-scale their home-growing efforts.

[147 words]

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GLOSSARY OF TERMS/PHRASES

Auxin – a plant hormone which causes the elongation of cells in shoots and is involved in regulating plant growth

Biodiversity – The variety of plant and animal life in the world or in a particular habitat, a high level of which is usually considered to be important and desirable.

Biophilia – an innate and genetically determined affinity of human beings with the natural world.

Gravitropism – a tropism (as of plant roots or shoots) in which gravity is the stimulus

Levitation - the action of rising or causing something to rise and hover in the air, typically by means of supposed magical powers.

Obesogenic – tending to cause obesity

Phototropism – the orientation of a plant or other organism in response to light, either towards the source of light (positive *phototropism*) or away from it (*negative phototropism*).

Precision Agriculture – a farming management concept based on observing, measuring, and responding to inter and intra-field variability in crops

Sequential Farming – Growing two or more crops in sequence on the same field per year. The succeeding crop is planted after the preceding crop has been harvested.

The Circular Economy – a idea based on the principles of designing out waste and pollution, keeping products and materials in use, and regenerating natural systems in business.

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INTRODUCTION

The UK population is growing, and its population density is one of the largest in the world at "*275 per square kilometer*" (Clark, 2021).

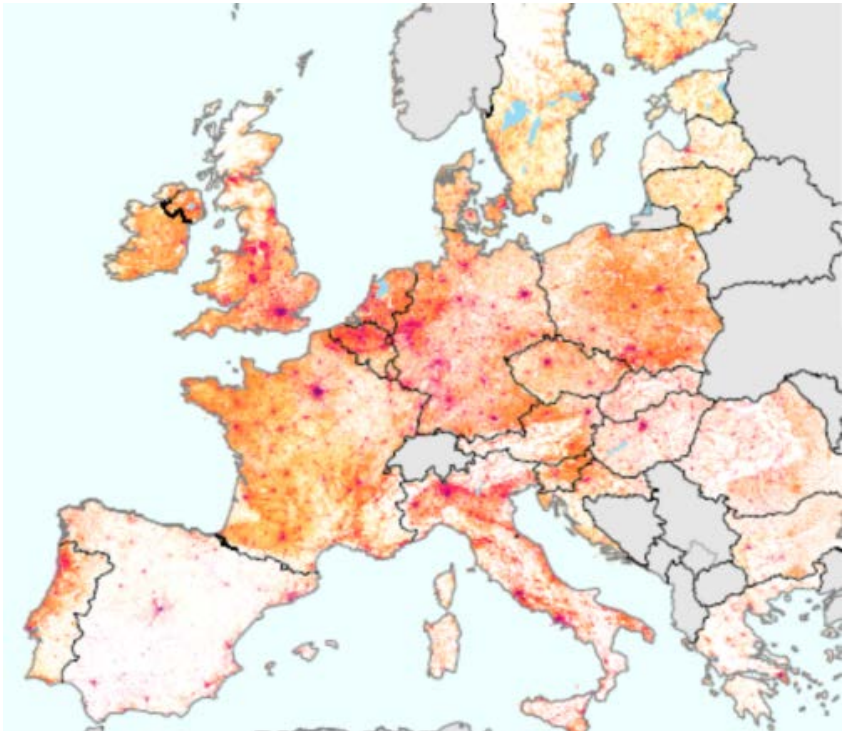


Figure 1: Population Density, EU Countries 2012 (Migration Watch, 2015)

A large quantity of fresh produce is imported from overseas, for example 84% of Britain's fruit (Jordan, 2020). Long food supply chains, caused by importation, have a significant carbon footprint. The UK needs to increase its domestic food production and not rely heavily on just-in-time food supply chains (Garnett et al., 2020) to increase the likelihood of reaching "*at least a 100% reduction of greenhouse gas emissions in the UK by 2050. This is otherwise known as a net zero target*' (Hirst et al., 2019). UK Food supply chains are vulnerable (Garnett et al., 2020) and hinder progress towards net carbon zero.

The problem of long food supply chains increases within urban areas where both domestic and international sourced food products need to be transported to consumers. Urban areas usually have higher land values and outdoor space is limited; therefore, urban UK consumers cannot make sustainable food choices. Unless consumers travel out of the city to local farm shops, the food they consume is dictated by supermarkets.

Soon, most British people will experience these problems as by 2050, 9/10 people will be living in urban areas (Evans & Davies, 2020).

These problems represent the design opportunity which will be explored within this project. The project will conclude with the design of a food production system which will persuade more urban families to convert to growing their own food by mitigating existing inhibiting factors. If more families have the choice to produce sustainable food, this will help the country with its eco-revolution but also reduce individuals' increasing feeling of guilt surrounding their carbon footprint.

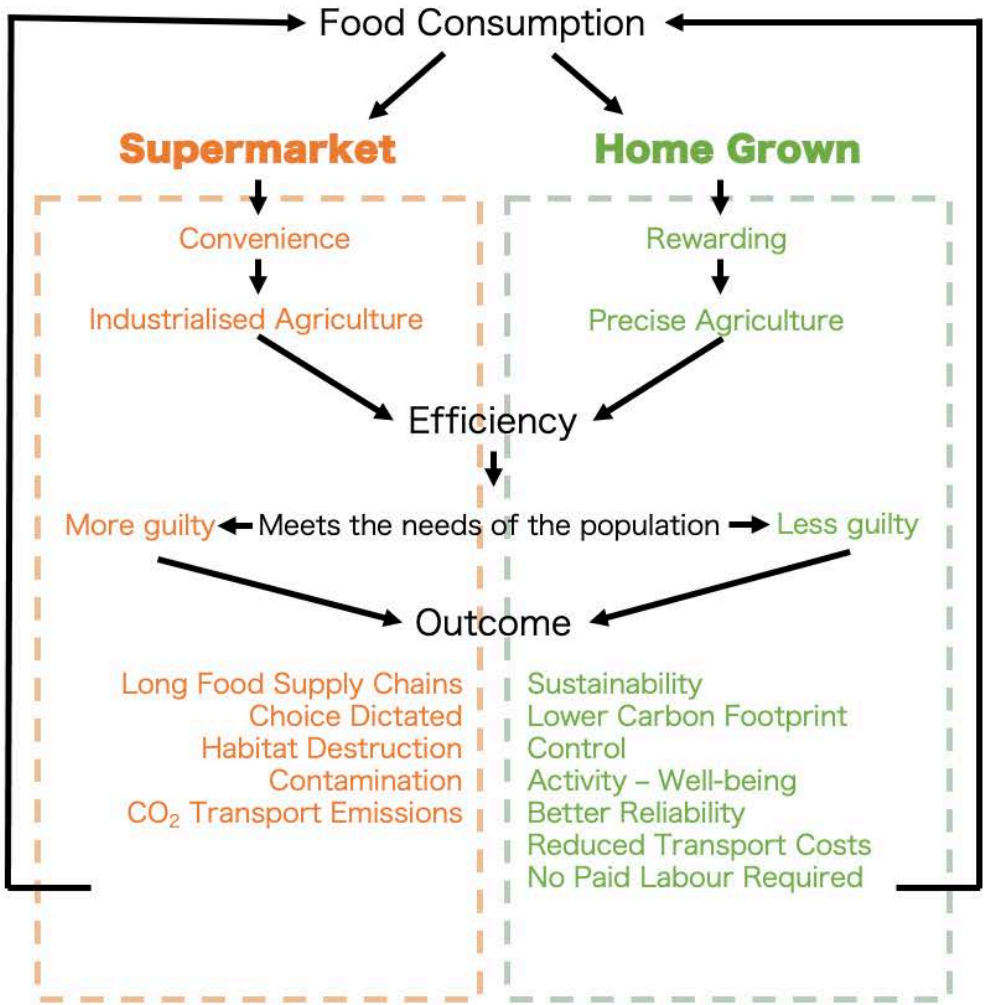
Currently, supermarket food is very convenient for the urban resident, but it has impacts that negatively affect the environment. If we could design a system which makes home grown food as convenient as supermarket food, then this would have benefits for the consumer and community.

Inhibiting factors in urban UK:

- Space is at a premium

By products of behaviour in urban UK:

- Increased traffic – Long food supply chains
- Choice dictated by supermarkets
- Habitat destruction
- Soil and water contamination
- Packaging waste
- Food waste
- Low prices forcing farmers to cut wages
- Unhealthy foods – obesity



Inhibiting factors in urban UK:

- Lack of space
- Unpredictable weather
- Lack of sunlight
- Lack of knowledge
- Lack of time
- Can be restricted by regulations and planning requirements

By products of behaviour in urban UK:

- Green space
- Insulation
- Reduced mortality – supports physical and mental health
- Reduces air pollution
- Supporting a circular economy?

Figure 2: Feedback Loop (Bostock, 2021)

STRUCTURE OF THE REPORT

The report structure will follow the Design Council's double diamond framework for innovation (Design Council, n.d.).

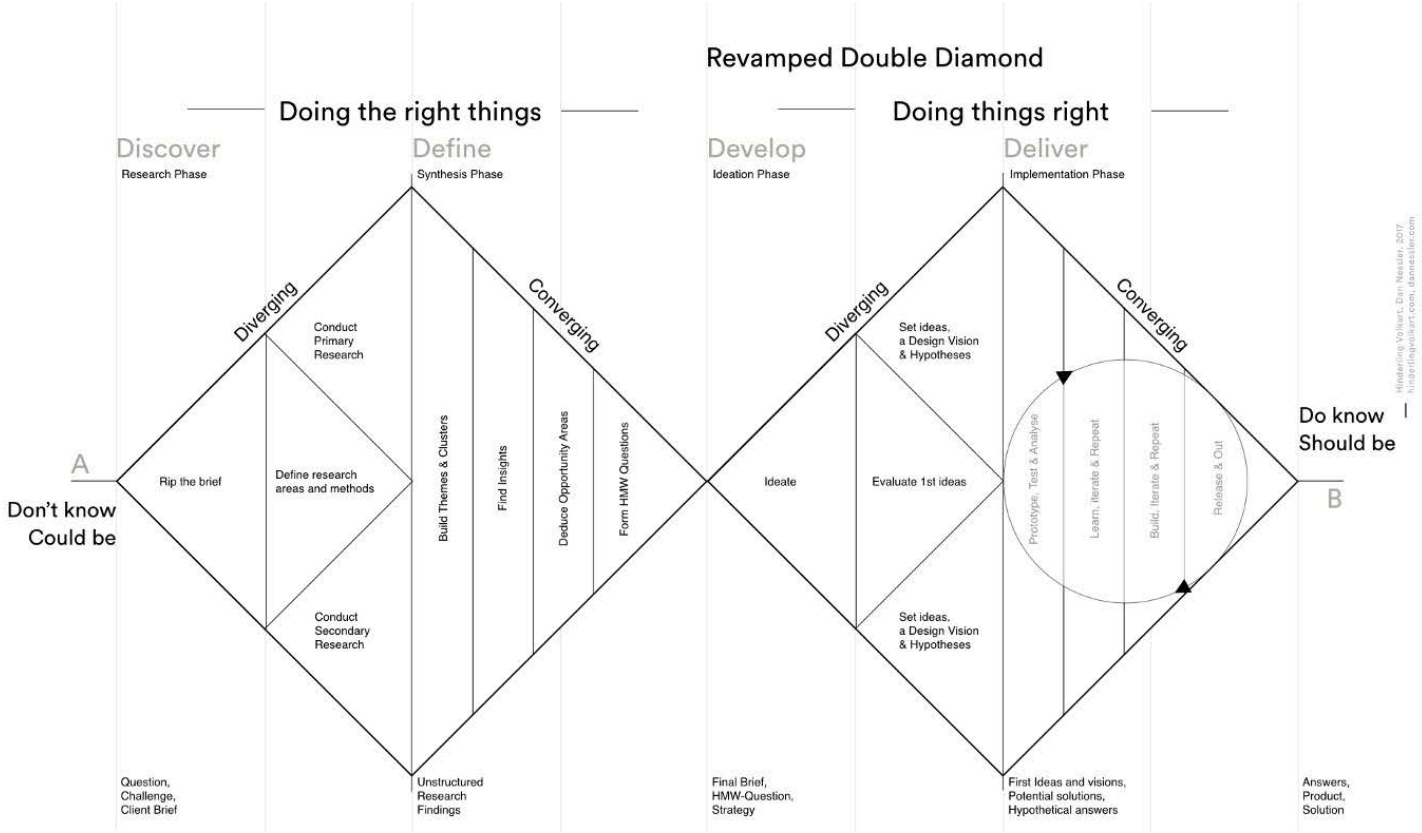


Figure 3: Double Diamond Framework for Innovation (Nessler, 2018)

1 RESEARCH

1.1 RESEARCH PLAN

To initiate the design process for this opportunity, a research question was defined to direct the project. The research question is:

How can we use precision agriculture and circular design principles together to allow urban families in the UK to engage in their own sustainable and efficient food production?

Figure 4: Research Question

From this question, the project could be organised using a timescale plan [**Appendix A**]. This started with creating a framework to define key themes which are explored through primary and secondary research techniques.

The decision was made to conduct primary and secondary research using the AEIOU framework to ensure all necessary data is captured. This is a useful guideline during exploratory studies as it allows the information to be strategically organised (Fitzpatrick, 2018). By embedding other research techniques within this framework, the research phase of the project should gain more valuable insights.

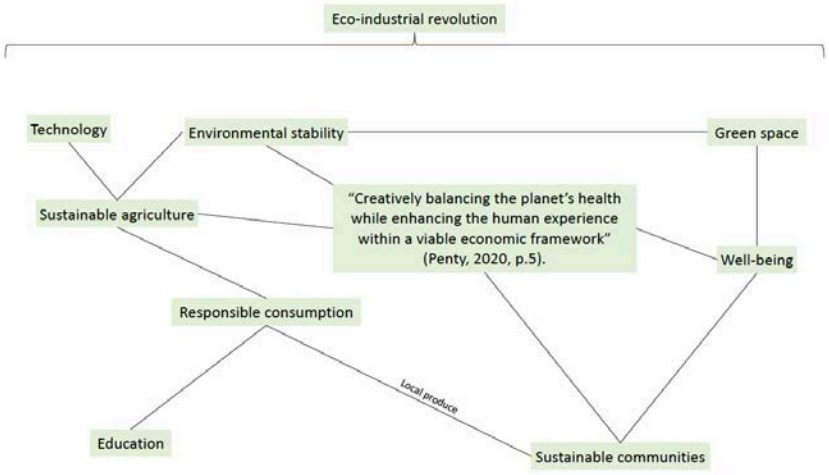


Figure 5: Conceptual Framework (Bostock, 2021)

1.1.1 RESEARCH OBJECTIVES

The research stage includes exploring the interconnected goals of the new system to ensure an optimal solution is reached. I will reflect and evaluate the decision making [**Appendix B**] throughout the project to guarantee success.

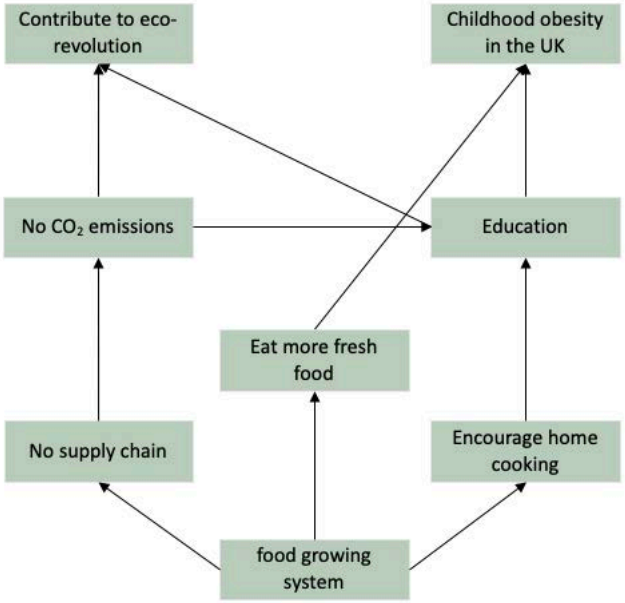


Figure 6: Interconnected Goals (Bostock, 2021)

1.1.2 ETHICS

During the study, ethical considerations will be used to protect participants in primary research activities and to make sure that the data is presented honestly with no bias. Before this project was started, I obtained ethics approval from the University.

1.2 THE DESIGN OPPORTUNITY

Figure 7: The Design Opportunity 5W's (Bostock, 2021)

The final major project context is to reduce the threat of climate change through mitigating the causes of the world's global environmental problems including over-population and over-consumption.

The design opportunity presents itself through existing eco-problems with food supply chains in the UK:

1) **Large food supply chains dictated by supermarket brands which emit excessive greenhouse gases**

Families in over-populated areas (urban) need to be able to produce local food efficiently to reduce carbon dioxide emissions from goods vehicles, this is required because "*transporting food within, to and around the UK produces 19 million tonnes of CO_2 annually – equivalent to around 5.5 million typical cars*" (Allen, n.d.).

2) **Countryside and other habitats are being destroyed for agriculture**

Producing food products in urban areas would reduce clearance for agriculture, for animal feed and palm oil. People who live in Urban areas are more likely to over-consume and therefore destroy more land than they need for their food supply.

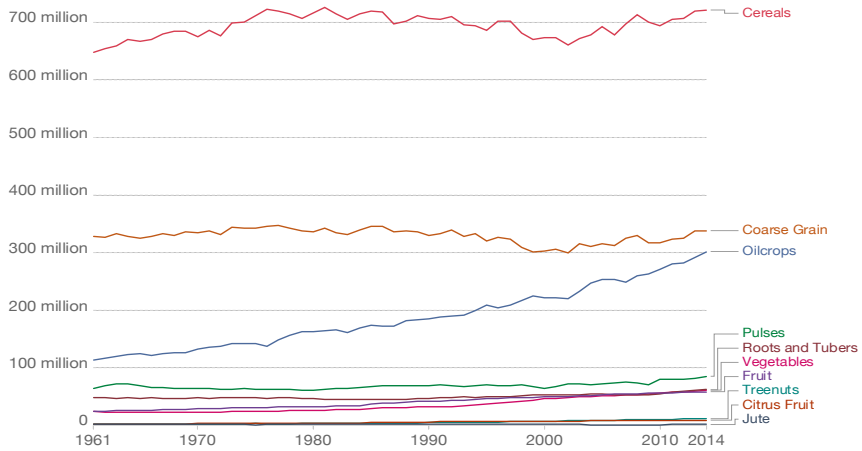


Figure 8: Global Agricultural Land Use (Ritchie & Roser, 2019)

3) **Use of industrial fertilisers to improve efficiency of production are contaminating water and soil**

Smart farming enables less contamination by industrial fertilisers. Mitigating these issues through product design would help to sustain eco-systems encouraging biodiversity in areas which otherwise would have suffered contaminated water and soil.

These eco-problems with the UK's food supply are interconnected and, if we could mitigate one of these issues, the rest would also be positively affected.

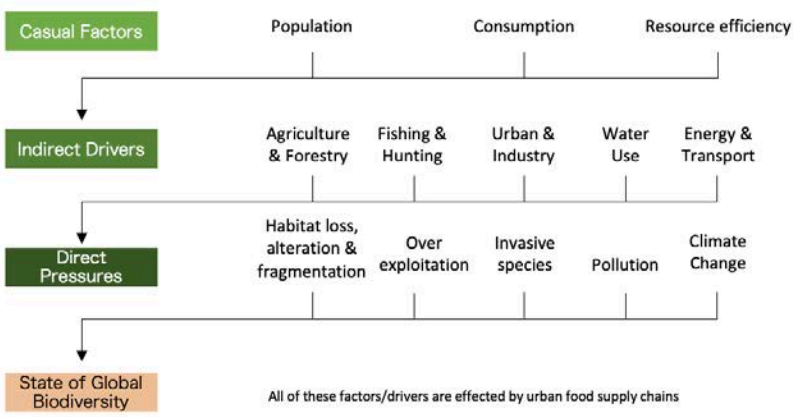


Figure 9: Food Supply Cause & Effect Diagram (Bostock, 2021) (Penty,2020, p.9)

To regenerate global biodiversity, the world needs to design out waste and pollution, keep products and materials in use and regenerate natural systems. This can be done through the work of product designers by applying circular economy principles to their designs and thinking regeneratively.

Food is a basic requirement to sustain humans however, this must "creatively balance the planet's health while enhancing the human experience within a viable economic framework" (Penty, 2020, p.5). i.e the system should provide food conveniently but also sustainably.

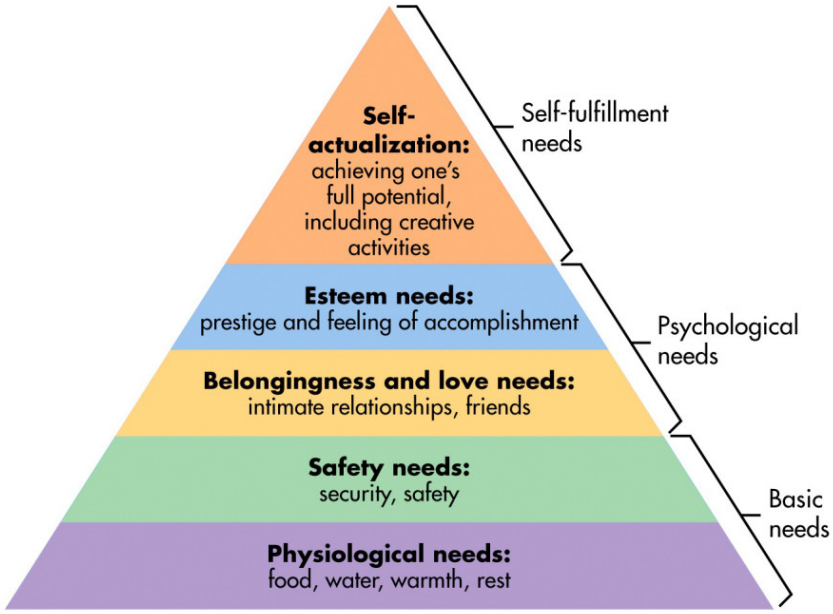


Figure 10: Maslow's Hierarchy of Needs (McLeod, 2020)

Considering the circular economy will ensure that the physiological needs are met as well as having balanced social and economic considerations.

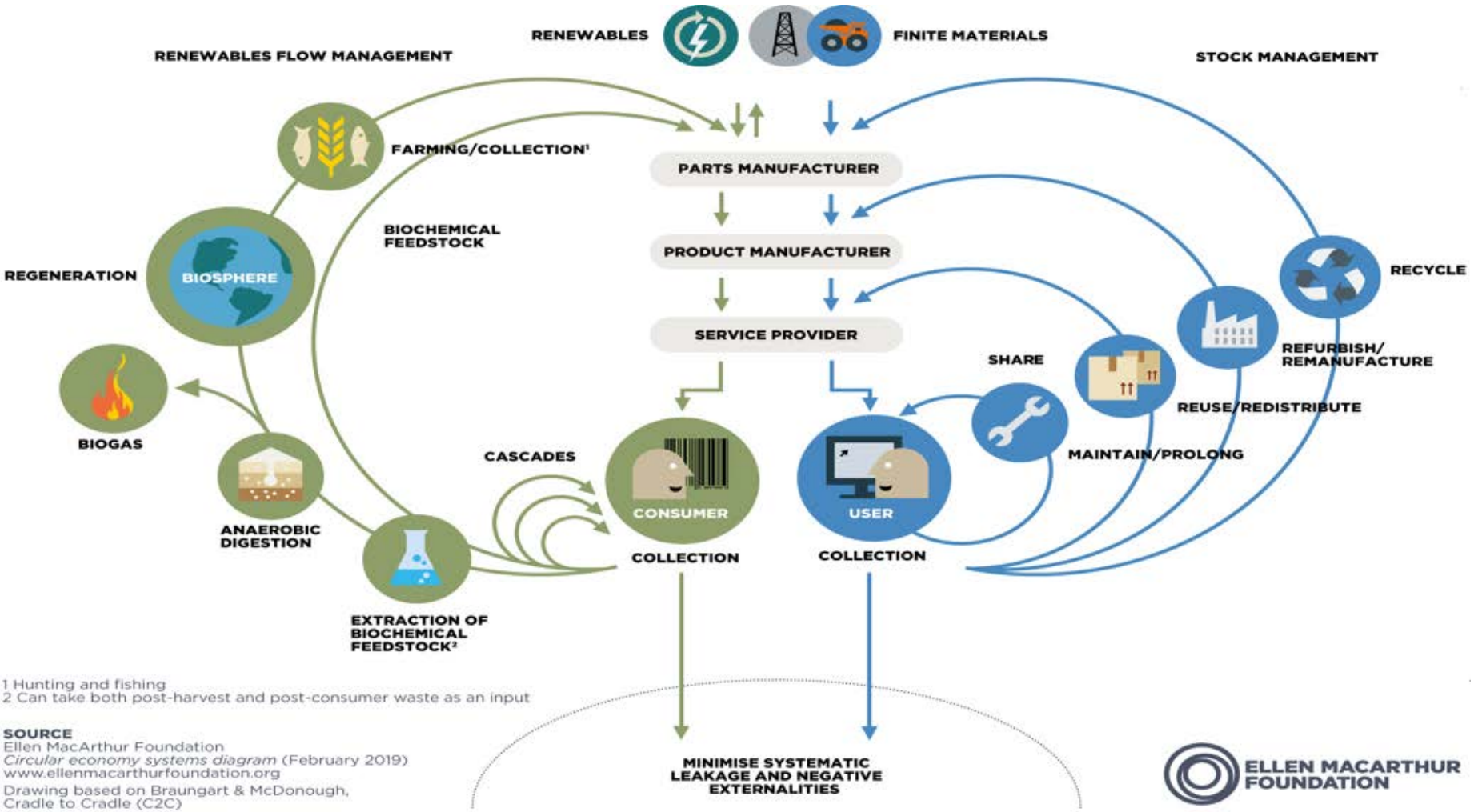


Figure 11: The Circular Economy (Ellen Macarthur Foundation, n.d.)

1.3 AEIOU – ACTIVITY

This section focusses on existing activities that solve long food supply chains through innovation. These case studies inspire ideas in a home context and define future research activities.

1.3.1 BOROUGH MARKET HYDROPONICS

There is a hydroponics farm in a disused London Underground tunnel that supplies Borough market with fresh food. The farm supports the problem as it has been identified that London's long food supply chains are unsustainable. This idea requires a limited amount of transportation, and the consumer needs to leave their house via transport to purchase. This can be taken further to reduce transportation by growing within the home.

Figure 12: Borough Market Hydroponics Farm (DiStasio, 2015)

1.3.2 TOWER GARDEN

The aeroponic product used within the Tower Garden creates a living rooftop. The garden provides food products for residents as well as involving them in the gardening activity as a community.

This system uses aeroponic technology to ensure food security. However, the vertical growing systems are expensive, and it is difficult to make a system like this economic.

This is a carbon zero approach to food supply; however, the yields may not be high enough for the whole residential building and harvest times are infrequent meaning that the residents cannot rely on this system as a reliable source of food.

Figure 13: Tower Garden (Tower Garden Team, 2020)

1.4 AEIOU – ENVIRONMENT

1.4.1 CLIMATE

The UK has a seasonal climate and does not experience extreme weather conditions that are common in other climates around the world.

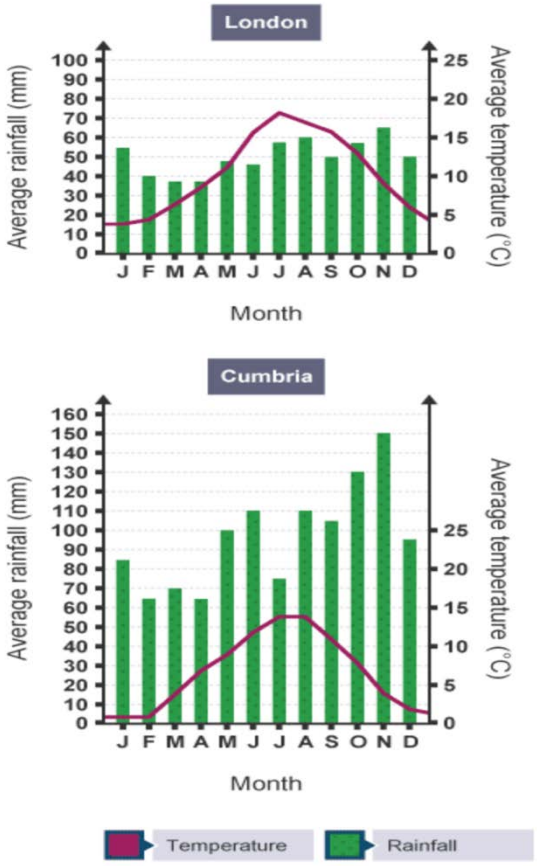


Figure 14: Climate in Opposite Ends of the UK (BBC, n.d.)

The UK weather is very hard to predict. (BBC, n.d.). This is due to the wind and jet stream defining the dominant weather system.

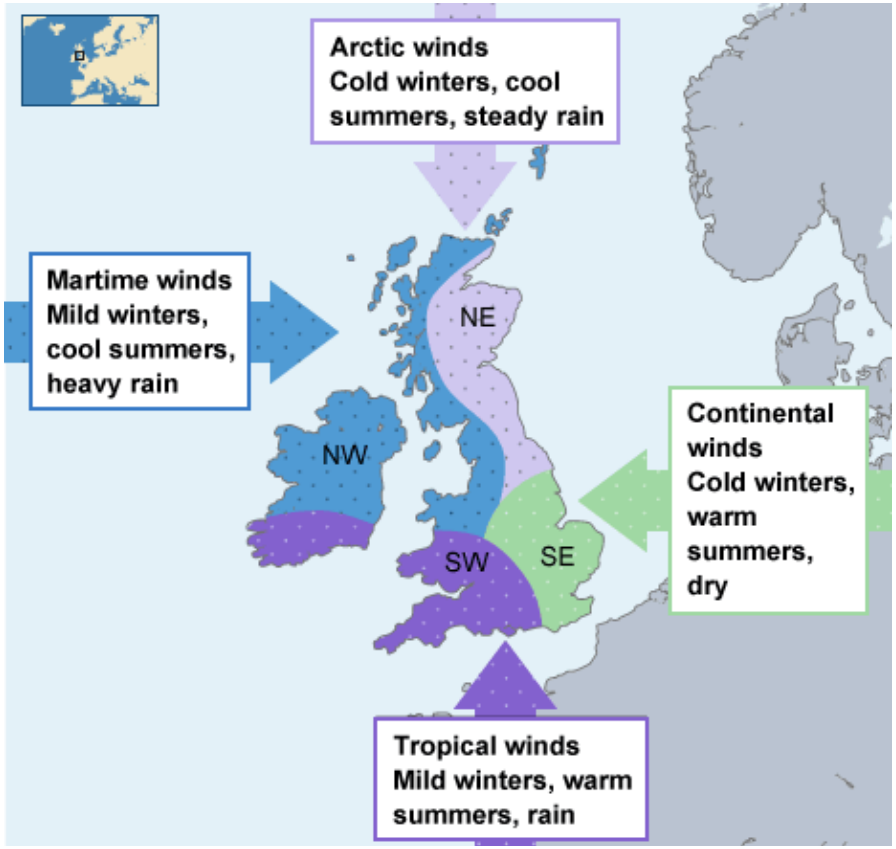


Figure 15: UK Weather Behaviour (BBC, n.d.)

This complexity makes agriculture and home gardening more complex. It requires more scientific knowledge to be successful. This often dissuades

people from joining the hobby. This suggests that the product should be for indoor use or be a closed/partially closed eco-system.

1.4.2 TYPES OF URBAN AREA

There are several types of personal urban area where this product could be situated to help the user with these problems. Areas include private gardens, balconies, rooftops, and inside the house.

Figure 16: Visual Inspiration - Living Staircase (Frearson, 2013)

Private gardens are usually small and expensive to buy. This often means that the space needs to be multi-functional constraining the design of the system. Balconies are small areas that deliver the requirements of plants and have good accessibility into living areas. However, Space efficiency is key in this environment. Rooftops are underutilised spaces which lend themselves to growing food due to large amounts of sunlight.

An emerging trend within the industry is “People wanting to bring the garden indoors, so plants that can handle lower light conditions and grow well in small pots work best.” (Sparks, 2020). Growing food within the house could overcome unpredictable weather, lack of knowledge, and allow high yields. Also, particularly in the aftermath of Covid-19, people are paying more attention to their psychological well-being and therefore are prepared to invest more to promote wellness and productivity. This might be due to the increase in biophilia design.

1.4.3 UK LEGISLATION

Most outdoor structures for agriculture have strict government legislation to adhere to which can deter potential users. For example, If the system is a temporary building type structure, then the area touching the ground cannot be larger than 15 metres (Garden buildings direct, n.d.). The product will also have to comply with the relevant BSI and CE standards such as BS ISO 21628 concerning gardening machinery.

Type of urban agriculture	Government or private support	Legislation and regulations
Allotments, community gardens, city farms	National lottery funding available. Protected by law.	Requires: • Planning permission • Use of contaminated land officer and allotment officer • Planning town act review Must comply with climate change act
Rooftop gardens	Privately Funded	Green roof does not require planning. No BREEAM accreditation for food production.
Rooftop greenhouses	Privately funded	Not commercialised at the moment. Farming not included within planning.
Peri-urban	Hard to justify doing this commercially at the moment. Companies can get investment. Agritech programs	Depending on size might require planning permission (Lopez-Capel, 2013)

Table 1: UK Urban Agricultural Legislation and Regulations (Bostock, 2021)

All available space for home growing is small within urban areas in the UK and therefore precise agriculture and the product needs to optimise the growth to ensure high yields, making home growing in an urban environment worthwhile. Community growth initiatives are hard to set-up due to government limitations including legislation and regulations and therefore to encourage more families to get involved, growing in the home would be the hassle-free alternative which also provides biophilic positive health effects in the home environment.

1.4.4 STAKEHOLDERS

Mapping out the stakeholders within the project was an important step to understand the relationships and the interconnections influencing the primary stakeholders. Depending on the type of product, the government and neighbors could have large influence particularly if it is a large structure. It has identified all the people or organisations that will have a stake in the design outcome as well as determining that the parents have the decision power, but the children may have large influence and be most benefitted.

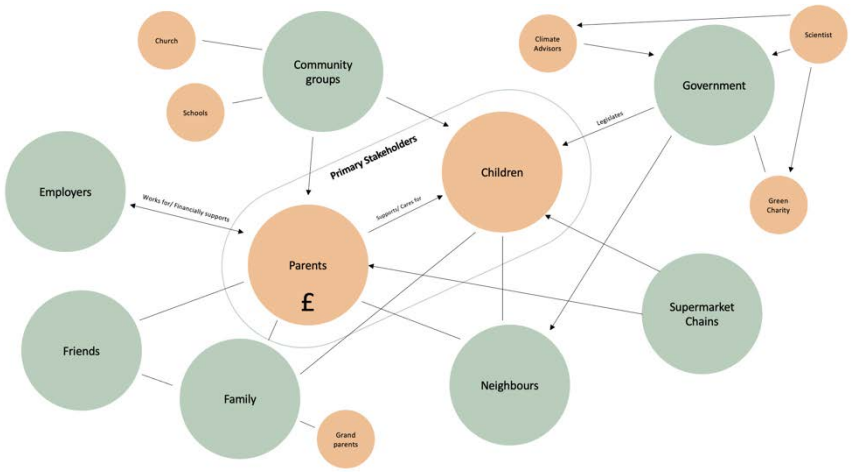


Figure 17: Stakeholder Mapping (Bostock, 2021)

1.5 AEIOU – INTERACTIONS

1.5.1 PLANT INTERACTIONS

There are many factors which need to be controlled to gain optimal yields. Depending on the type of food being grown, different conditions are required for optimal yield.

Category	Name	Temperature hardiness	Water requirement	Soil	Fertiliser	Bloom Time	Space	Common problems
Hardy Vegetables	Onions	High	Regular	Acidic soil	General liquid fertiliser	July to September	Small	Onion white rot Leek rust
	Broccoli	Mid-low	Infrequent	Alkaline retentive soil	Vitax Q4	Late spring, late summer	Medium	Birds Caterpillars
	Cabbage	High	Regular	Alkaline soil	Nitrogen, phosphorus, potash	Most of the year	Small-medium	Cabbage root fly Caterpillars
Half-Hardy Vegetables	Carrots	Mid	infrequent	Sandy soil	Phosphorus rich organic feed	May - October	Small	Carrot fly Aphids
	Lettuce	Mid-low	Regular	Alkaline soil	General fertiliser	May- November	Small	Lettuce root aphids Slugs and snails
	Potatoes	Mid	Frequent	Slightly acidic soil which is water retentive	Potato fertiliser	June to October	Small	Potato blight Potato blackleg
Tender Vegetables	Beans	Mid	Regular	Acidic to neutral soil	potassium	Mid summer - fall	Small (vertical)	Black bean aphid Chocolate spot
	Tomatoes	Low	Very frequent	Loamy neutral soil	Mixed fertiliser	July - September	Small	Blossom end rot Tomato blight
Extremely Tender Vegetables	Cucumbers	Low	Very frequent	Neutral soil	Organic feed	July - October	Small-Mid	Whitefly Cucumber mosaic virus
Fruit	Apples	Mid	Regular	Well drained acidic loamy soil	Vitax Q4	Summer, fall	Large – if planted	Apple scab Apple sawfly
	Oranges	Very low	Regular	Slightly acidic	Liquid phosphate	Summer to fall	Large	Psorosis bark scaling virus disease
	Bananas	Very low	Regular-infrequent	Loam-based neutral compost	Nitrogen, phosphorus, potassium	Summer	Large	Sigatoka Black leaf streak
	Strawberries	High	Regular	Well drained, alkaline soil	Vitax Q4	Summer, fall	Small	Grey mould Powdery mildew

Table 2: Growing Requirements for Fruit and Vegetables (Bostock, 2021) (RHS, n.d.)

From Table 2, we can conclude that berries, salad foods and hardy vegetables are the easiest to grow because of their resistance to temperature fluctuations, limited space, and the number of times the plant can be harvested. However, how useful are these foods? For example, onions cannot be eaten on their own and need to be put with something else. The decision on what food to grow within the system needs to consider ease, utility, and impact on the environment.

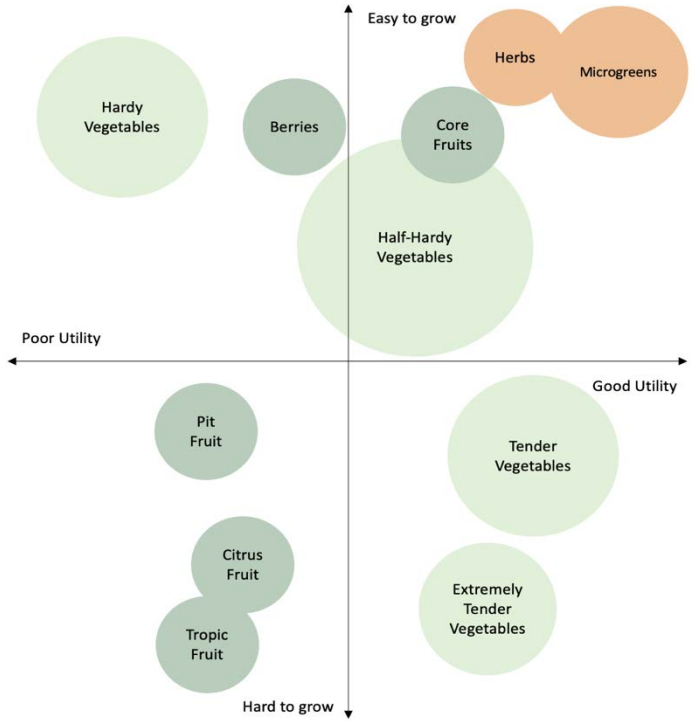


Figure 18: Food evaluation (Bostock, 2021)

Microgreens are easy and quick to grow as well as good at making healthy foods tasty and nutritious. Microgreens can be added to a diverse range of meals.

Garnishes do not have a long shelf life, so it makes sense for a short supply chain however during a visit to an urban supermarket, most of these products originate from all over the world. This is frustrating from a sustainability point of view as these can be easily grown within the UK.

Figure 19: Image showing fresh garnish section in urban supermarket (Bostock, 2021)

Encouraging typical supermarket buyers into home growing will require a system which proves to the user that it is easy and convenient with benefits to the environment, changing attitudes in favour of home growing.

1.5.1.1 SEQUENTIAL FARMING

Sequential farming is used by agricultural farmers to efficiently use the space available to create the highest yields possible. It is "a form of multiple cropping in which crops are grown in sequence on th e same field, with the succeeding crop planted after the preceding crop i s harvested" (Riyo, 2018).

Families like buying food from the supermarket as it is easy and on-demand unlike traditional home growing. However, if we can use sequential farming methods to make home growing more reliable and easier, this would convert supermarket buyers.

This is possible with microgreens because the growing cycle is much shorter than other foods and therefore this type of system could ensure that the family has food every day of the week. This would solve the issue of impatient children who want to see what they have grown very quickly. Also, quick growing and the introduction to this method of farming could encourage the user to scale-up their home growing in the future.

Figure 20: Sequential Farming within Agricultural Practices (Mankoo, 2014)

1.5.1.2 COGNITIVE WALKTHROUGH

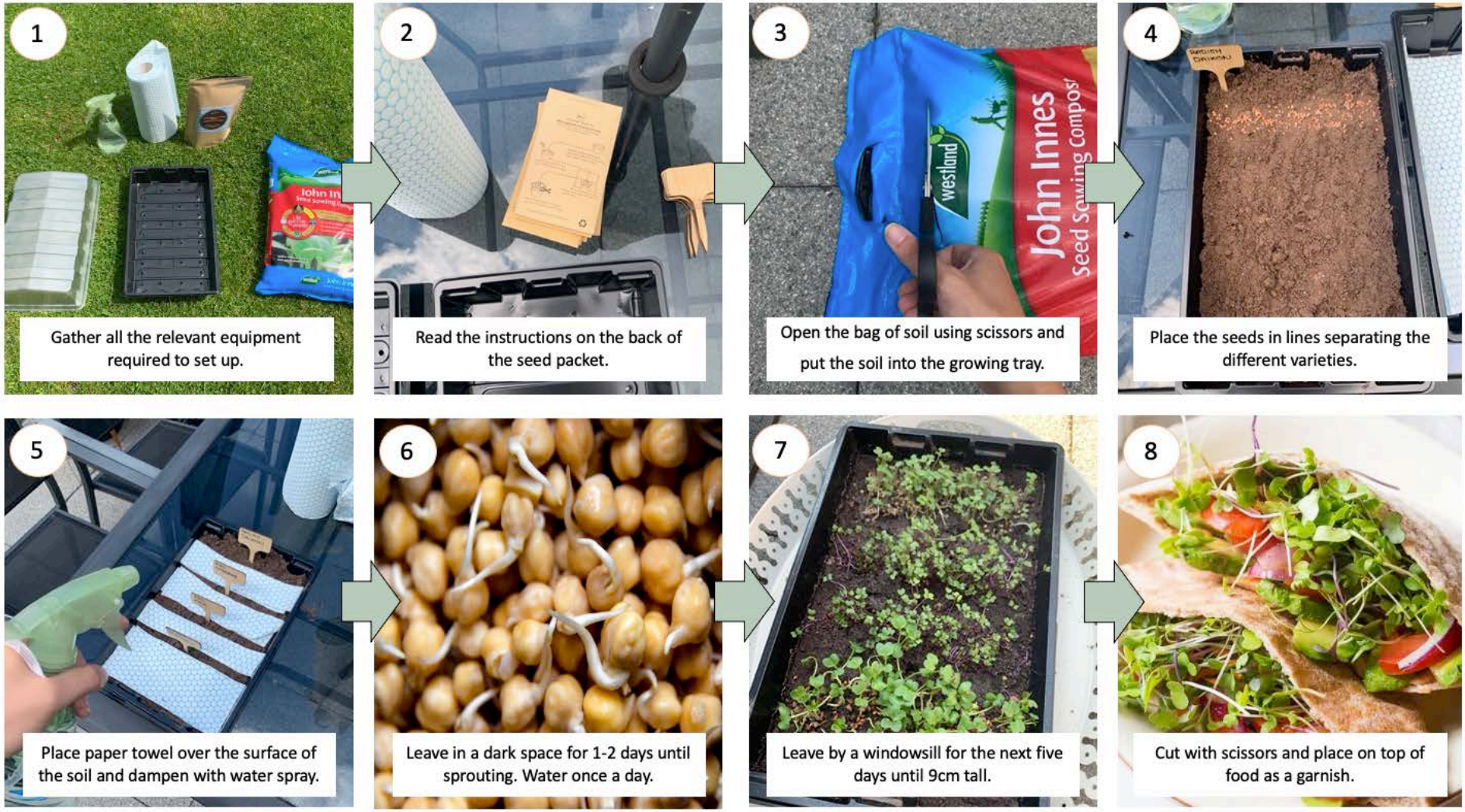


Figure 21: Cognitive Walkthrough - 5 varieties of Microgreens in a soil medium (Bostock, 2021)

The cognitive walkthrough proved that the growing cycle of microgreens is easy and short enough to be able to be incorporated into a sequential system if this was deemed optimal. During this experiment, I worked out how much soil surface area was required to garnish a meal for a family of four.

Figure 22: Soil surface area required to garnish a meal for a family of four (Bostock, 2021)

Total soil surface area (cm^2) = Area required to feed family of four (cm^2) x Days in growing cycle 350cm^2 = 50cm^2 x 7 350cm^2 is quite a lot in an indoor urban environment, so we need to explore whether we could decrease the growing time using technology.

Figure 23: Soil Area Calculations (Bostock, 2021)

1.5.1.3 PLANT HORMONES

There are five main plant hormones that coordinate plant growth and development [**Appendix C**] (BioNinja, n.d.).

Technology could be used within an indoor environment to control phototropism by stimulating the auxin plant hormone when there is an inconsistent lighting environment. This will ensure that the plant remains stable and receives the optimal light throughout its lifetime. You can also control plant growth by stimulating geotropism (Foot, n.d.). A plant growing negatively geotropic could reduce space required for the growth and therefore support vertical farming.

Figure 24: Geotropism (Foot, n.d.)

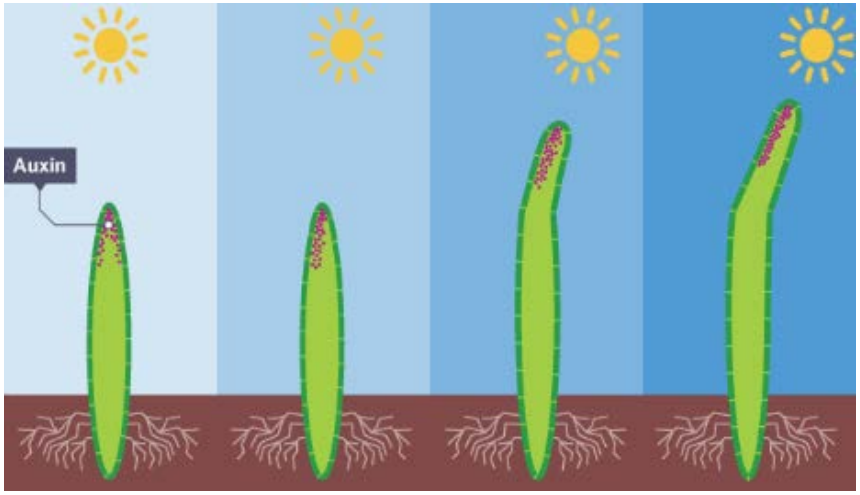


Figure 25: The effect of Auxin – Phototropism (Foot, n.d.)

1.5.2 HUMAN INTERACTIONS

Within all products it is important to consider usability. This product is aimed at families which is a large demographic. This means the anthropometric data will be wide ranging as the product needs to be suitable for both small children and adults. This might mean that we reduce the amount of user touch points.

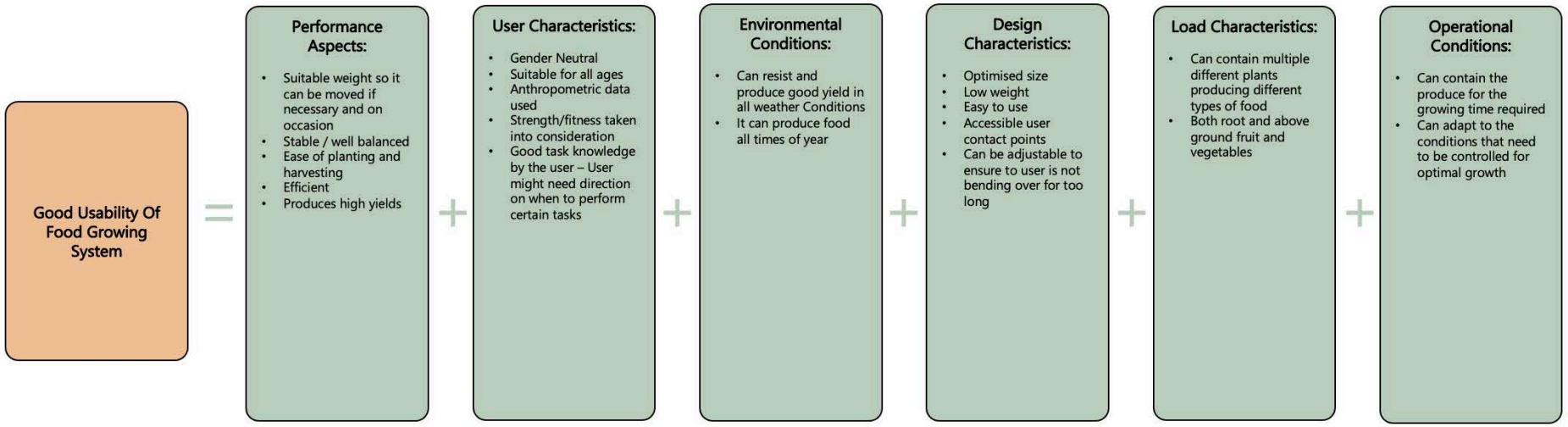


Figure 26: Formula for good usability in a food growing system (Bostock, 2021)

1.6 AEIOU - OBJECT

1.6.1 TECHNOLOGIES

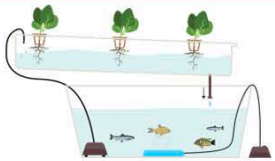
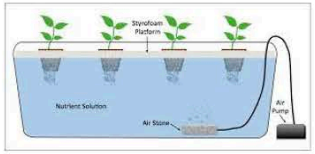
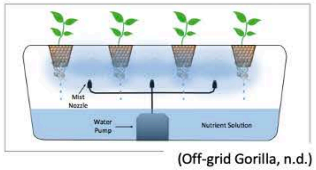
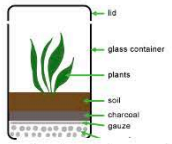
Technology/method name	Description	Diagram	Pro's	Con's
Aquaponic	"The cultivation of plants and aquatic animals in a recirculating environment" (You Matter, 2020).	 (Trees, 2020)	• Two agricultural products produced from one nitrogen source • Water-efficient • No need for fertilisers (You Matter, 2020)	• High initial start-up costs • Need for expertise in how the natural world works • Fewer management options • High energy demand (You Matter, 2020)
Hydroponic	"An effective method for growing plants that places the plants in a water solution that's rich in nutrients"(Sensorex, n.d.).	 (Square mile farms, 2020)	• No soil involved • Not dependant on location – can be used anywhere • Can control climate • Water-efficient • Optimal use of nutrients • Fast growing rate (Conserve energy future, n.d.)	• Time consuming • Need for expertise on using equipment and following techniques • High levels of water and electricity required – safety precautions needed with this mix (Conserve energy future, n.d.)
Aeroponic	"Aeroponic systems nourish plants with nothing more than nutrient-laden mist. The concept builds off that of hydroponic systems, in which the roots are held in a soilless growing medium, such as coco coir, over which nutrient-laden water is periodically pumped" (Barth, 2018).	 (Off-grid Gorilla, n.d.)	• Maximum nutrient absorption due to no growing medium • High yields • Fast growing rate • Little space required • Great educational tool (Trees, 2021)	• Time consuming • High initial start-up costs • Requires technical knowledge • Susceptible to power outages (Trees, 2021)
Terrarium growing	"A terrarium is a miniature ecosystem made of soil, rocks, and plants arranged in closed glass jar or container. A closed terrarium creates its own atmosphere and needs little from the outside except light. Think of a terrarium as a mini greenhouse!" (Sweetser, 2020).	 (Beginner indoor gardening, n.d.)	• Watering is required irregularly • Low maintenance	• Can be more susceptible to over watering • Direct sunlight can kill plants inside • Prone to mould
Soil growing	The most natural and traditional method of growing plants is in soil where the soil substance gives the plant it's nutrients through its roots.	 (Conway, 2013)	• Natural environment • Lower costs • More forgiving for busy growers • Better flavour • Soil naturally adjusts itself (Swing, 2020)	• Longer growing cycle • Pests • Requires time to set-up • Larger space required • Smaller yield (Swing, 2020)

Table 3: Food Growing Technologies (Bostock, 2021)

1.6.1.1 PRECISION AGRICULTURE

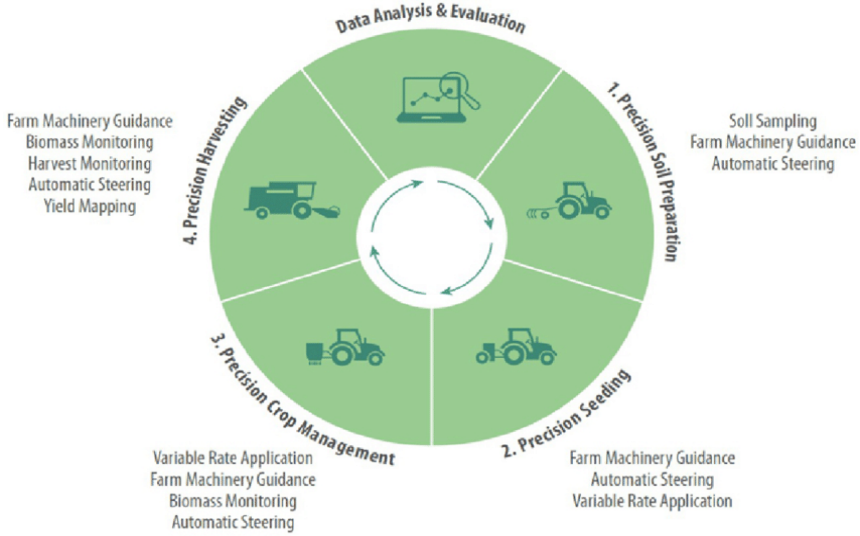


Figure 27: Precision Agriculture Infographic (Robert, 2020)

Precision agriculture (PA) is the science of improving crop yields and assisting management decisions using high technology sensor and analysis tools (Singh & Bao, 2020). This group of technologies is used to increase production, increase efficient use of land, reduce labour time, and ensure the effective management of growing factors such as the use of fertilisers and irrigation.

Precision agriculture tools will play a vital role in this growing system because to persuade more people to become home growers we need to take the complexity out of creating large nutritional yields. Tools like sensors will be able to control and optimise plant growth by manipulating plant hormones by changing growth variables such as sunlight, water, nutrients etc.

1.6.2 THE MARKET LANDSCAPE

The gardening tool market size is expected to grow to have a revenue forecast of 102.3 billion USD by 2025 (Grand view research, 2016).

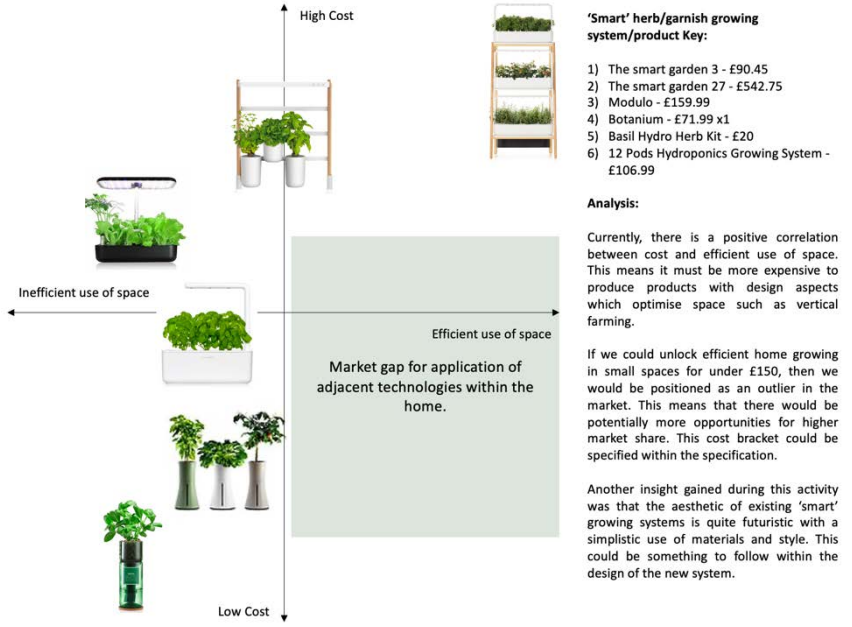


Figure 28: Benchmarking 'smart' herb/garnish growing systems (Bostock, 2021)

1.7 USER

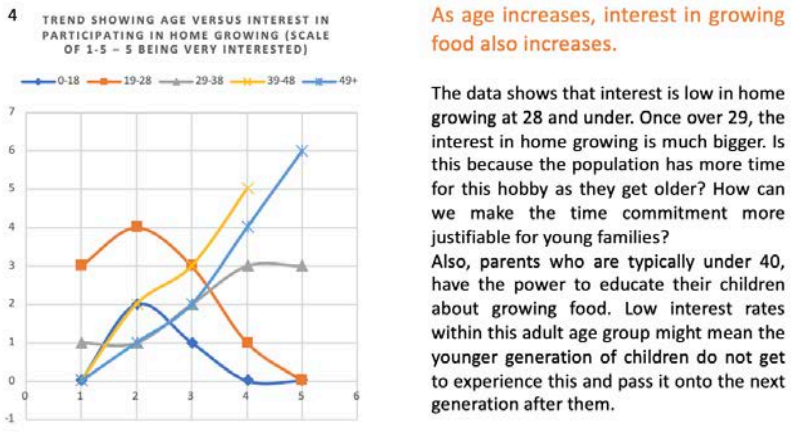


Figure 29: Graph showing age versus interest in home growing (Bostock, 2021)

The questionnaire results [**Appendix D**] suggest that product should be aimed at young families as this demographic has the largest potential to solve the problem of low home growing rates and childhood obesity. Children need to experience home growing to feel confident in their abilities to participate in these activities once they are adults. To be able to educate children, the product needs to keep the children's attention to be able to be educational and rewarding, therefore we require the plants to be fast growing. Herbs and garnishes are easy and quick to grow as well as being used in most meals and therefore, having a supply of these on demand would be convenient as well as rewarding. Children can be impatient to harvest their crops so a sequential farming system could overcome this by providing something new every day of the week.

(Sweet London, n.d.)

(Britten, 2020)

(Location works, n.d.)

The Jones Family

The Jones family consists of Karen and Paul with their two children called Lily and Sophie (5 and 7 years old). They currently live in a urban terraced house in South London. Family life is busy with the children participating in many after school activities. Currently, the family relies on supermarket food however they like the thought of growing their own produce as they think that it will be rewarding and educational for the children.

The families requirements for a home growing system:

- Reliability
- Efficient and high yields
- Educational
- Produces food with high nutritional value and good utility

Push factors

- Eco-friendliness
- Healthy lifestyle
- Reduced cost of food
- Supporting physical and mental health – reduce likelihood of childhood obesity
- Rewarding

Pull factors

- The convenience of supermarket produce
- The children are quite impatient waiting for things to grow
- Not having the knowledge required to grow food economically, efficiently and reliably
- Lack of space
- Unpredictable weather
- Lack of time

Figure 30: Young Family Persona Profile (Bostock, 2021)

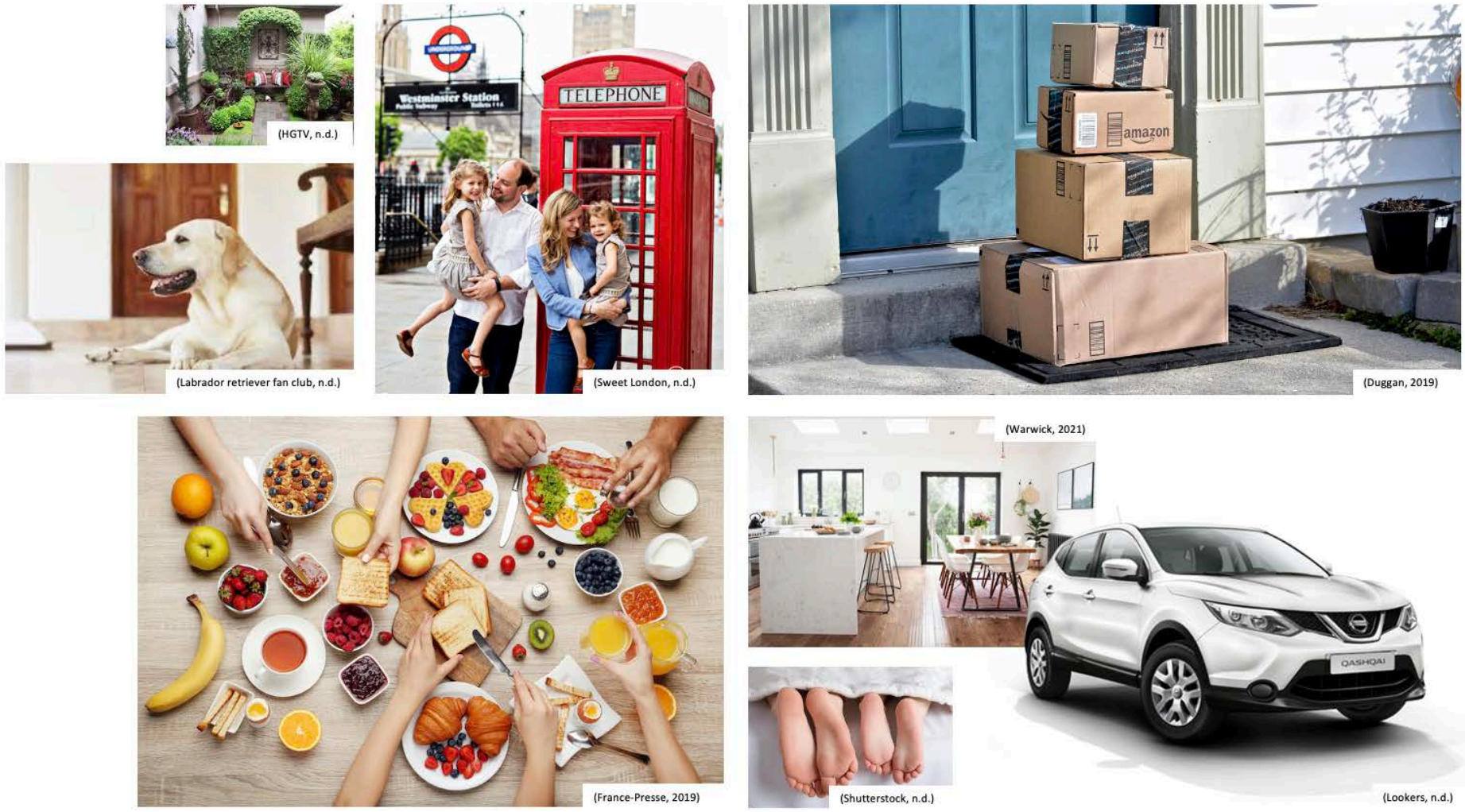


Figure 31: Persona Lifestyle Board (Bostock, 2021)

1.7.1 CULTURAL CONSIDERATIONS

Gardening and growing foods is firmly rooted in British cultural heritage. Gardens and allotments are deeply embedded within our national landscape (Bonny, 2010).

However, as we can see from the questionnaire results as well as other secondary sources of information, younger people aren't so keen on having gardening as a hobby and to produce their own food for their families as previous generations.

Particularly during the World Wars, "it was recognised by the UK's adversaries that cutting off imports could lead to mass starvation, so Britain was forced to act" (Farm & Country magazine, 2019). The grow your own attitude thrived in a time of crisis and had positive effects for the environment. The question is, could climate change have a similar effect in 10-20 years' time?

Also, it is widely recognised that making your meals yourself is better nutritionally for you. However, lifestyles in the UK are restricting how much families partake in making and growing a homemade meal from scratch. This is leading to an increase of childhood obesity in the UK as well as worldwide.

Targeting this new system at families should help to reduce childhood obesity by encouraging home growing and cooking homemade meals.

1.7.1.1 CHILDHOOD OBESITY

- Urban areas are obesogenic environments which means that they are environments that increase our risk of becoming overweight (Fernandez, 2018)

- The UK has one of the highest rates of childhood obesity in Europe (Barakat, n.d.).

- "In 2018, 18% of children aged 5 to 15 ate five standard portions of fruit and vegetables per day" (The health survey, n.d.).

- "Those who grow their own (food) are 3.5 times more likely to consume the recommended five portions a day of fruit and vegetables" (Benenden Hospital, n.d.).

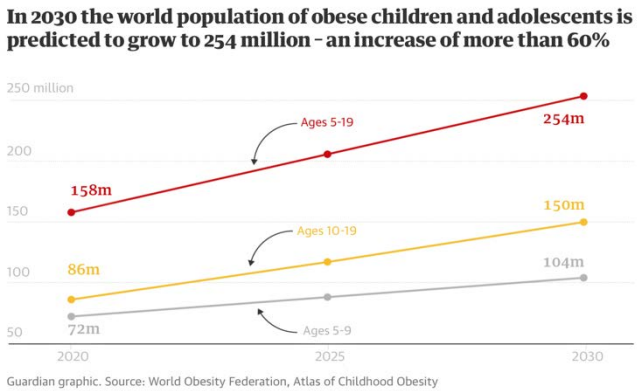


Figure 32: Graph Showing Childhood Obesity Trends (Boseley, 2019)

1.8 BRIEF & SPECIFICATION

1.8.1 DESIGN BRIEF

How might we develop a home growing system which enables families to grow their own food easily, converting and changing attitudes of supermarket parent buyers to a more sustainable lifestyle choice of home growing. Whilst also, ensuring their children eat healthily.

Figure 33: Design Brief (Bostock, 2021)

1.8.2 DESIGN SPECIFICATION

	Specification Point
001	Must be usable for children above the age of five with adult supervision
002	Must use precision agriculture and therefore must include sensors to monitor crops
003	Must include safety features such as electrical shut off systems
004	Must be a compact size with a potential soil surface area more than 50cm^2 per day of growth
005	Must be ergonomically efficient
006	Must be user maintainable – repairable
007	Must be between £50-£150
008	Must grow quick growing, nutritious and useful crops
009	Must provide the family food for throughout the year, month, and week
010	Should mitigate long term injuries associated with gardening
011	Should include materials which are sustainable and/or can be recycled and therefore ensuring an end-of-life plan
012	Should include an irrigation system
013	Should assist the user in making optimal decisions for the health of the crop
014	Should have a sophisticated aesthetic
015	Should limit all carbon dioxide emissions throughout its lifetime including during manufacture
016	Should be a closed or partially closed eco-system
017	Could be a starter kit to change attitudes towards growing your own food at a manageable level first – educational tool
018	Could include mobile or smart connectivity
019	Could make sequential farming easier for the user
020	Could assist the with the growing problem of childhood obesity in the UK

Table 4: Product Design Specification (Bostock,2021)

2 IDEATION & DEVELOPMENT

The hierarchy tree diagram reflected upon the research to create open-ended questions to drive the sketches and initial ideas.

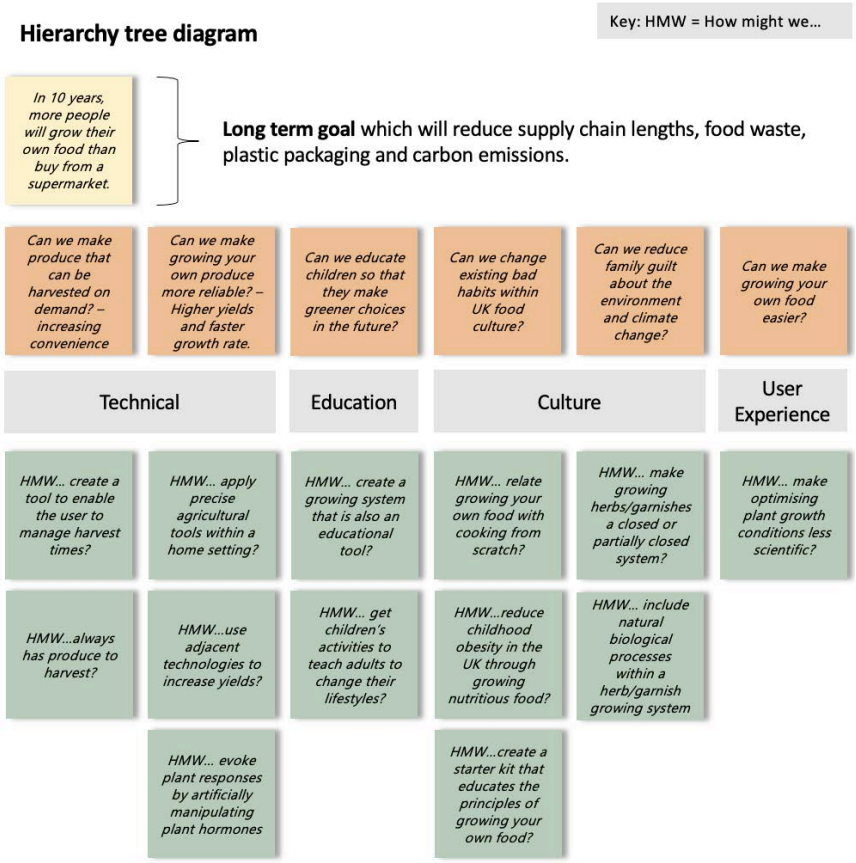


Figure 34: Ideation Tree Diagram (Bostock, 2021)

Figure 35: Thumbnailing (Bostock, 2021)

The initial ideation made me realise that culture is a big problem within the context of this project however if we solve the user experience and technical problems this should change attitudes towards growing your own food. To change attitudes, education is required to teach the principles of growing so users feel more confident to scale-up their efforts. The tree diagram and the subsequent sketches made me realise that all the issues are interlinked and need to be solved together in a single tool/system.

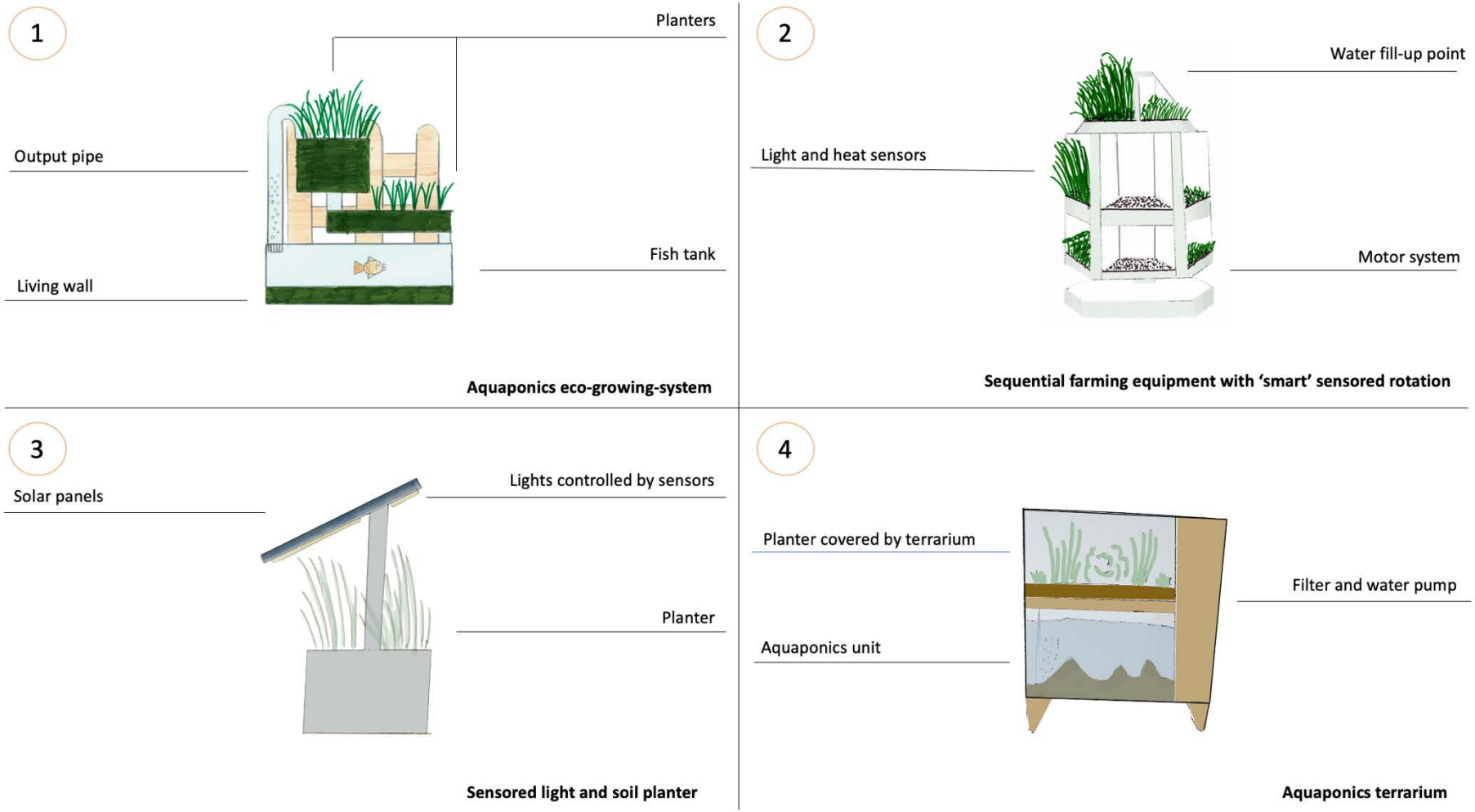


Figure 36: Initial Concepts (Bostock, 2021)

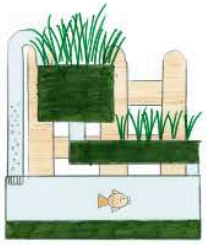
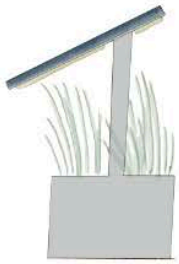
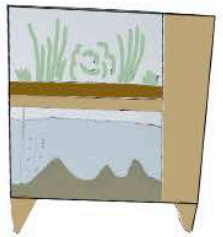
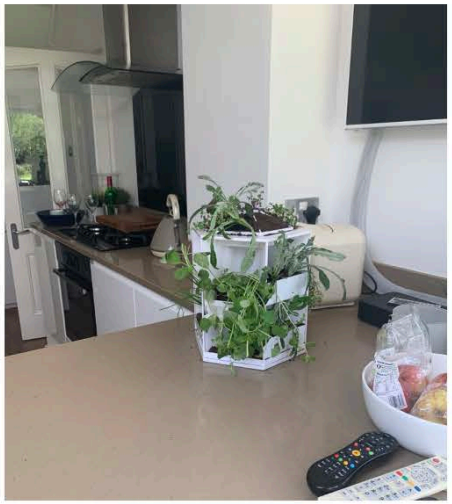
		1. Aquaponics eco-growing system		2. Sequential farming equipment for the home		3. Sensored light and soil planter		4. Aquaponics Terrarium	
Criteria	Loading 0-3-5-7								
Child-friendly	7	3	21	4	28	3	21	3	21
Size	7	2	14	4	28	3	14	1	7
Reliability	5	3	15	5	25	3	15	3	15
Efficiency	5	3	15	5	25	2	10	3	15
Cost	5	2	10	4	20	3	15	2	10
Sustainability	5	4	20	4	20	3	15	2	10
Total:		95		146		90		78	

Table 5: Initial Concept Evaluation (Bostock,2021)

2.1 PROTOTYPING



Identified problems during the testing of the prototype:

- The prototype can only be used once the seeds have sprouted because there are no enclosed dark spaces
- The prototype requires a motor to turn the product to overcome phototropism which can inhibit growth – this 'wastes' electrical energy
- Each section might not be identifiable and the user might mistakenly harvest the wrong crop first
- The prototype does not have a light source and therefore cannot easily control this element required for optimal growth
- The soil escapes the containers quite easily and this could create a mess which is difficult to clean up within indoor environments - children using the product will only make things worse

These issues should be addressed within the next stage of development.

Figure 37: Prototyping (Bostock, 2021)

2.2 DEVELOPMENT

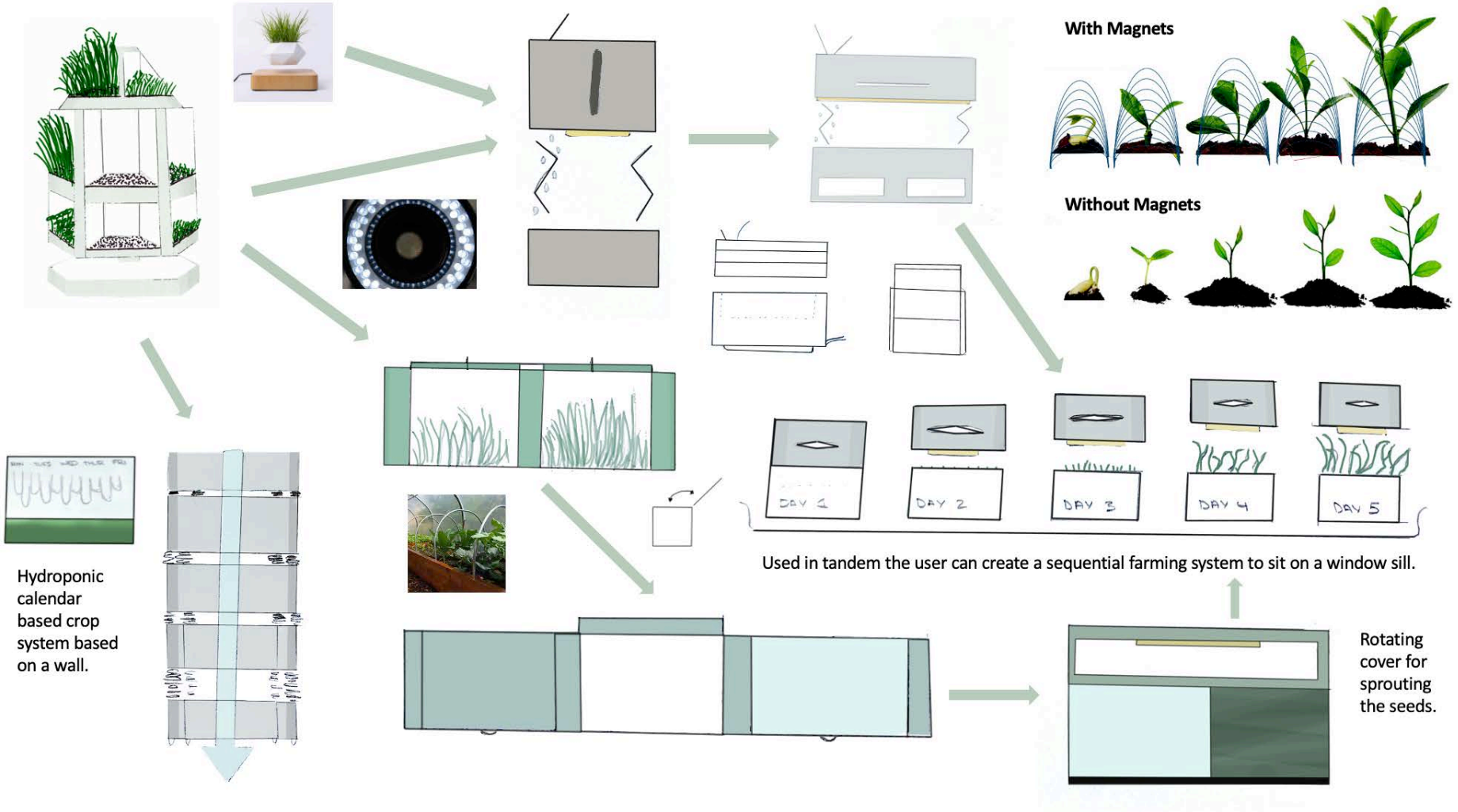


Figure 38: Development Sketches (Bostock, 2021)

During the development sketches I tackled the weak points identified within the testing of the prototype. One of the issues was that the product did not consider the sprouting stage that requires a dark environment. The product needed to be developed to adapt the lighting environment depending on where the microgreens are in the growing cycle. During these sketches, I realised that magnetic levitation would allow the light to move closer or further away from the seeds/plants by changing the electrical current. After further research it was discovered that magnetic treatment of seeds and magnetised water “enhances germination by speeding up the formation of protein in the cells” (Grant, 2021)

2.2.1 TECHNICAL DEVELOPMENT

Although using Magnetic levitation within the product, reduces growth time, enhances seed germination, and therefore yield (Fu, 2012) as well as minimising material usage there are still a few problems which need to be overcome to include it in a commercial product.

Problems with magnetic levitation:

1. Levitation stability – Can manipulation of electrical currents overcome this? Will we need a structure to hold the magnets in place?

2. Health and safety risks – How strong is the magnetic field? Will it interfere with other household items? Can a user who has metal in their arms/hands use it?

3. Relatively expensive – Will the product be good value for money with the additional benefits? Will this change in the next 10 years when adjacent products use the same technology? E.g Maglev’s

2.2.1.1 MAGNET TESTING

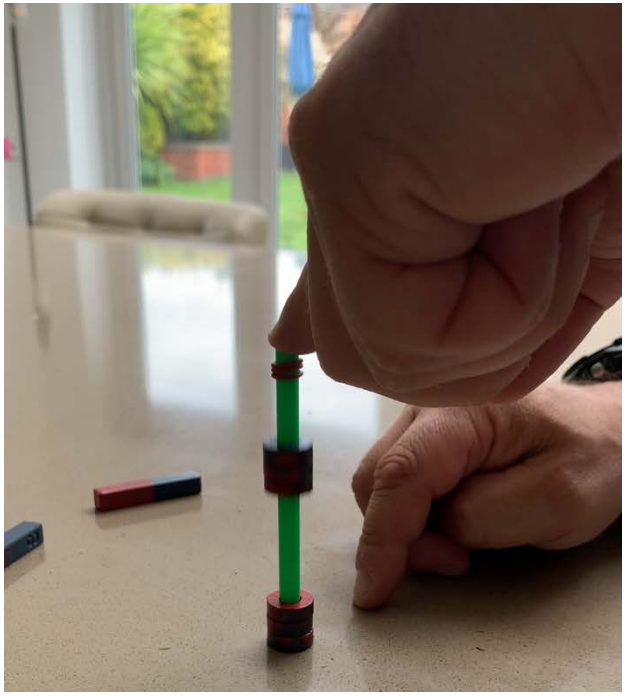


Figure 39: Magnet Experiment (Bostock, 2021)

I used permanent magnets to prove the theory of magnetic levitation. Here I used a plastic guide to keep the magnets in position and the top

magnet levitated. When the top magnet was pushed down it bounced back upwards to maintain its position.

Permanent magnets work in the same way as electromagnets. Electromagnets are more desirable in this application because the current can control the strength of the magnets and therefore determine the distance between the light and the pot at different stages in the plant growing cycle.

2.2.1.2 LINEAR MAGNETS

“Linear motors are electric induction motors that produce motion in a straight line rather than rotational motion. In a traditional electric motor, the rotor spins inside the stator; in a linear motor, the stator is unwrapped and laid out flat and the "rotor" moves past it in a straight line” (Woodford, 2020).

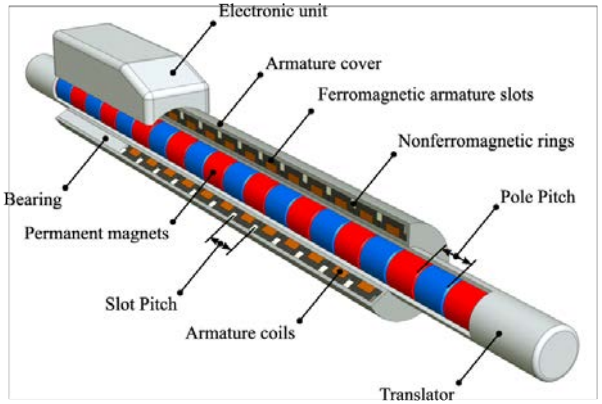


Figure 40: Linear Magnets (Zamanian & Richer, 2017)

Linear magnets would be more suitable than magnetic levitation because they use less power, have the same positive effects on plant growth, increase safety, a cheaper option and increase stability. However, linear magnets will still be able to create a magnetic field which is required for enhancing sprouting seed growth and to automate light movement to ensure the plants get the correct amount of light in different stages of the growing cycle.

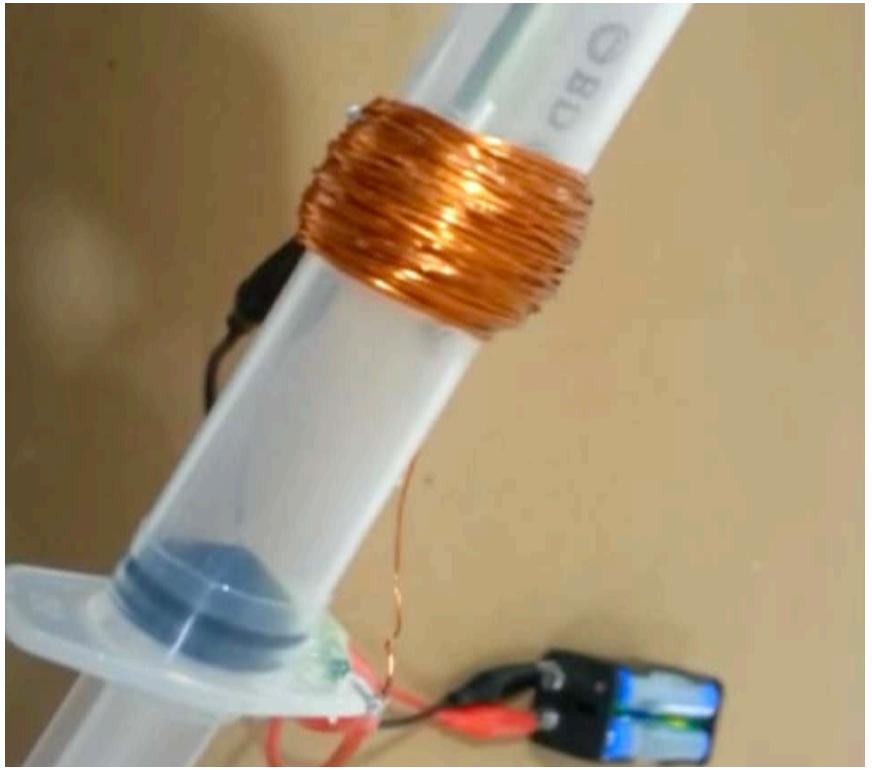


Figure 41: Linear Magnets Experiment (Bostock, 2021)

Adding linear magnets to the product will mean that the aesthetic of the light casing and pot will change to include a telescopic style leg which cases the magnets. These will be coloured green, so they do not disrupt the aesthetic too much and make the product still look like it is floating.

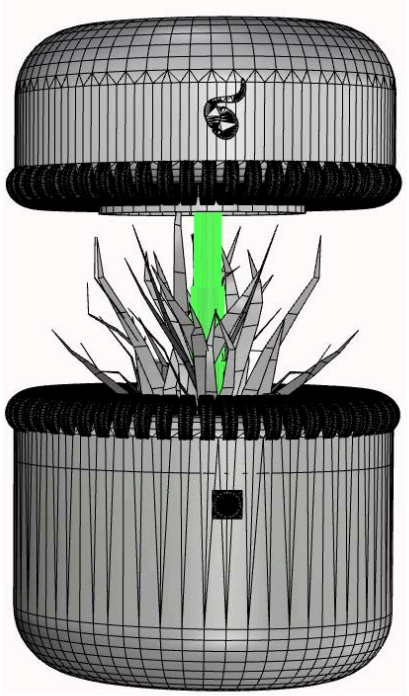


Figure 42: Technical Development Drawing (Bostock, 2021)

2.2.2 CMF DEVELOPMENT

Material choice is an important part of this project so that the final product perceives its sustainability ethos through the design itself as well as in the way it works. An evaluation matrix was used to narrow down the material options against key criteria.

Material Name	Polycarbonate	Durat	Bamboo	Perspex Acrylic Sheet
	 (Sheet Plastics, n.d.)	 (Durat, n.d.)	 (Evo Design, n.d.)	 (Cut my plastic, n.d.)
Sustainability	4/10	10/10	8/10	3/10
Appropriateness	4/10	7/10	6.5/10	5/10
Manufacturing feasibility	7/10	7/10	6.5/10	5/10
Total:	**15/30**	**24/30**	**21/30**	**13/30**

Table 6: Material Evaluation Matrix (Bostock, 2021)

Durat is the optimal material for the main body of the growing system because it is a unique, sustainable material which contains post industrial plastics as well as being 100% recyclable (Durat, n.d.). The company references the circular economy and the material is part of a closed material cycle. By the time this product makes it to market, these types of materials will be more economically feasible within lower end products.
This material is usually used on shelving and worktops and therefore applying it within the shelves with structural support in other materials would be appropriate. Other materials such as Perspex or glass might be appropriate if light needs to be let through.

DURAT®

(Durat, n.d.)

After asking Durat some questions about applying this material within this type of context, they sent me some samples so I could get a feel for the material.

I was amazed by how tactile the material was and how it gave a luxurious feel to any product as well as showing itself as being recycled and sustainable.

Figure 43: Durat (including sampling) (Bostock, 2021)

Durat was the top scoring material in the evaluation. After asking Durat some questions about applying this material within this type of context, they sent me some samples so I could get a feel for the material.

The material was tactile, and it will give a luxurious feel to any product as well as showing itself as being recycled and sustainable.

The material which received the second highest score within the evaluation was bamboo. Bamboo would contrast the Durat's aesthetic and give warmth to the product if it was added as a secondary material.

Figure 44: Bamboo Material Samples (Bostock, 2021)

The material choices drove the overall CMF and branding of the final product.

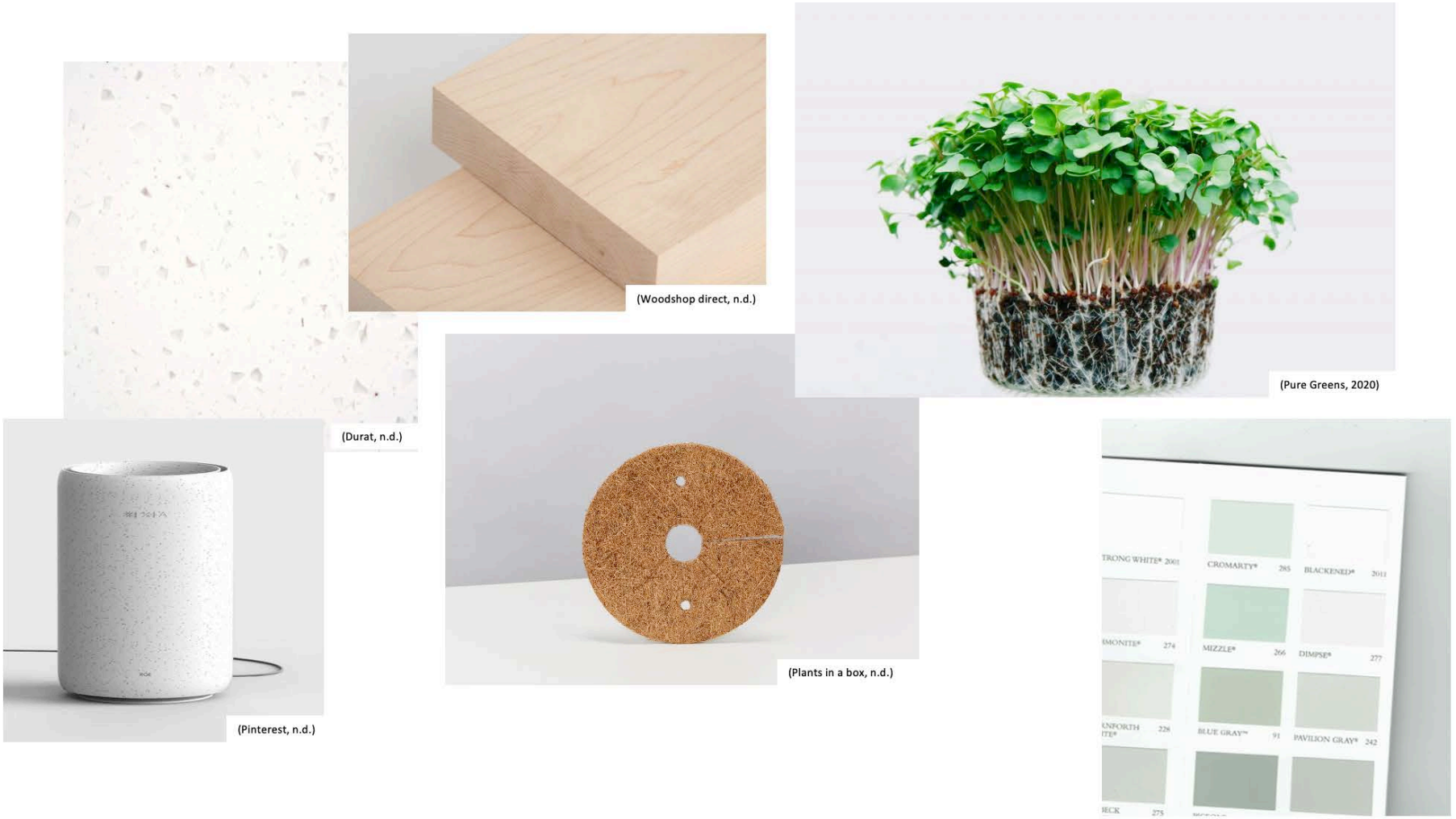


Figure 45: CMF Board (Bostock, 2021)

The final product will have an aesthetic that is inspired by the modernist movement including Scandinavian modern style. This means that the product will have clean lines, functionality, a neutral palette and consider affordability. The Scandinavian style will be merged with an eco-aesthetic including sustainable materials and greenery. The food produced will have a biophilia effect on the living space which particularly important in the wake of the Covid-19 pandemic to get closer to nature and therefore improve mental wellbeing.

Figure 46: Brand & Aesthetic Development (Bostock,2021)

3 FINAL PRODUCT

Figure 47: Final Product Render (Bostock, 2021)

Figure 48: Final Product Render (back view) (Bostock,2021)

3.1 HOW DOES THE FINAL PRODUCT ASSIST WITH SEQUENTIAL FARMING?

Microgreens take up to 7 days to grow however the magnetic interactions through the lateral magnets can reduce this down to 5 days. The product creates a cycle which requires the user to put water into the base, harvest from one pot and sow seeds in another depending on where each pot is in the growing cycle every day.

Figure 49: Daily Use of HelloSprout (Bostock, 2021)

Providing Superfood every day to young children and making it fun to produce will help to reduce childhood obesity. Sequential farming helps to create a fun growing system by rewarding the children everyday once set-up with new varieties of microgreen. Each pot contains soil as the growing medium which will produce 56cm^2 of microgreens which is suitable for four plates of food to be garnished.

Figure 50: HelloSprout Growing Sequence (Bostock, 2021)

On day 1, the seeds require a dark environment so the electric current will be at its lowest to keep the lid on top of the pot. However, as the seeds sprout and become into microgreens, they need more light so the electric current increases to increase the distance between the light and the pot.

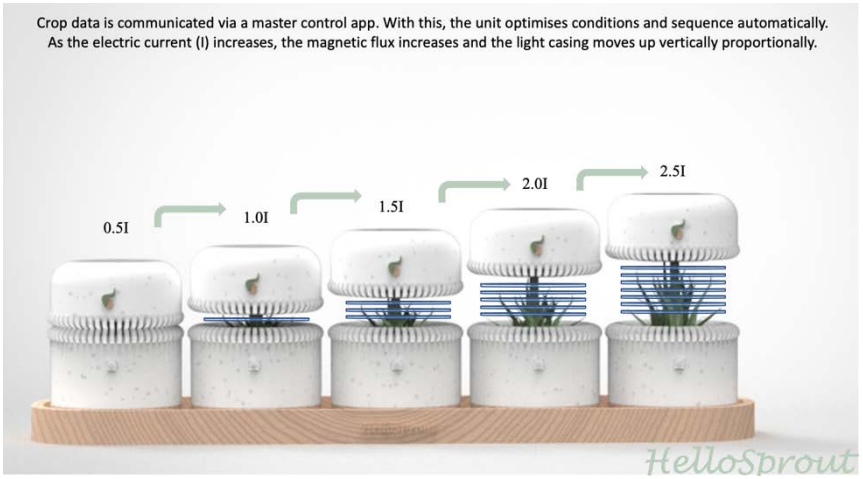


Figure 51: Magnetic Function of HelloSprout (Bostock, 2021)

The linear magnets help to create the light and dark environments as well as creating high frequency electromagnetic fields to constitute a genuine environmental stimulus able to evoke specific responses in plants that increase seed germination, plant growth and yield. The frequency required to be produced by the linear electromagnets is between 300MHz – 3GHz to influence the plants significantly (Davies et al., 2016).

3.2 PRECISION AGRICULUTURAL ASPECT

The product contains sensors to detect changes in environment as well as to monitor the growth of the microgreens. The harvesting and sowing needs to be logged for the product to understand when the lights need moving and turning on etc. It would be too expensive to place a physical interface onto the product itself to communicate to the technology that a plant has been sown or harvested so therefore we had no choice but to involve a mobile app to do this. Most parents and even children have a 'smart' phone so this should be accessible and convenient. This also, could help parents to plan meals as when they are in the supermarket, they can check what is due to be harvested.

Figure 52: HelloSprout Mobile App Precision Agriculture Tool (Bostock, 2021)

So that HelloSprout can work together successfully, several components such as Bluetooth modules and PCB's will need to work together.

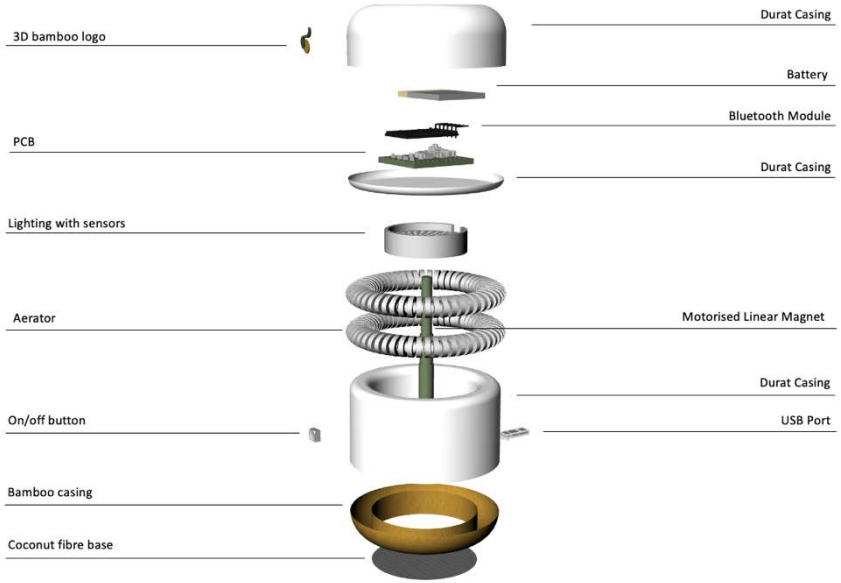


Figure 53: HelloSprout Exploded View Diagram (Bostock, 2021)

3.3 WHERE WILL THE PRODUCT BE USED?

As this product is a starter kit, the small scale is important to ensure that it is manageable while the members of the family learn. Also, it is less commitment giving up an unused workspace or windowsill for this type of product particularly in urban environments where space is at a premium so this will be the environmental focus.

Urban London will be the target for early adoption for HelloSprout because residents here experience the extremes of the identified problems including limited space and childhood obesity.

Adoption in this area would have the most impact on childhood obesity in the UK overall because it is more prevalent in London (Trust for London, 2020).

The value of land in London is high, HelloSprout allows the user to grow much smaller foods which have the same nutritional content as normal sized food inside, using space that wasn't necessarily used.

Figure 54: HelloSprout in Use (Bostock, 2021)

3.4 EDUCATIONAL USP

USP - HelloSprout is a starter kit that changes attitudes towards growing your own food. It is an educational tool that introduces the importance and viability of growing your own food on a manageable scale. The user can take the principles and methodology learnt whilst using this product to scale up and grow other foods within their means. HelloSprout is a tool that adds value to a child's education because it allows them to learn how to grow a diverse range of crop and cook a range of different foods with it. As well as having the same nutritional value as normal sized fruit and vegetables.

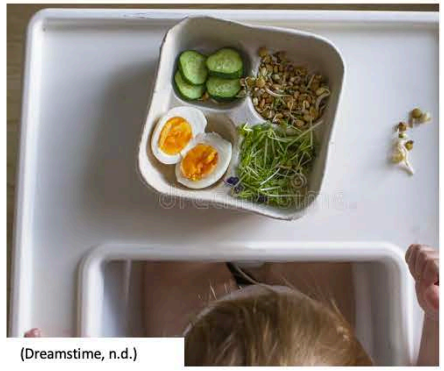
Variety of Microgreens which can be grown:

- Cauliflower
- Broccoli
- Cabbage
- Watercress
- Radish
- Arugula
- Lettuce
- Endive
- Chicory
- Radicchio
- Dill
- Carrot
- Fennel
- Celery
- Garlic
- Onion
- Leek
- Amaranth
- Quinoa swiss chard
- Beet
- Spinach
- Melon
- Cucumber
- Squash
- Wheat
- Corn
- Barley
- Chickpeas
- Beans
- Lentils

(Petre, 2018)

Variety of foods which can be cooked using the microgreens grown:

- Pizza
- Burgers
- Pasta
- Pesto
- Salsa
- Guacamole
- Savoury Pancakes
- Salads
- Sandwiches
- Sushi
- Garnishing fish, meat or shellfish
- Puddings such as strawberry tart
- Smoothies/juices
- Soup
- Casseroles
- Omelettes
- Avocado toast or other savoury toasts



(Dreamstime, n.d.)

Figure 55: HelloSprout Educational USP (Bostock, 2021)

The product will include a recipe book to encourage home growing and develop skills on how to use the food that is produced. The recipe book will ensure that parents and children can cook together to make nutritious homemade meals. This will encourage families to change their lifestyles from ready-meals and takeaways and therefore reduce childhood obesity for this generation but also the next generations after that.

A physical recipe book was included with the product as research states that “readers retain more information when they read physical books” (Holstein, 2020). Also, it is difficult for more than one person to look at a phone screen which can be quite small, when cooking the child and parent will be working together. It requires near to no effort to flick through a book when the product arrives however, some families may not even download an app if this contained the recipes instead.

3.5 COSTINGS

The research phase determined that HelloSprout should not cost more than £150 so it is an outlier in the market. With a few adaptations to the business plan such as selling the product on an in-house website, this is possible.

Part no.	Part name	QTY	Brand	Material	Supplied or sub-contracted out?	Manufacturing process	Part Cost per product(£)	Source
001	Coconut fibre base	5		Coconut fibre	Sub-contracted	Sheet material die-cut to size	£1.99	(Rover UK, n.d.)
002	25 page Recipe book	1		Paper	Sub-contracted	250gsm gloss paperback	£1.80	(Book printing UK, n.d.)
003	Durat pot	5		Durat	Sub-contracted	Cast	£16	
004	On/Off button	5		Polypropylene	Supplied		£2.75	(Alibaba, n.d.)
005	Bamboo tray	1		Bamboo	Sub-contracted	CNC Machine	£17.50	
006	Linear magnet	5	Chihai		Supplied		28.15	(Bang good, n.d.)
007	Light	5	Ledil		Supplied		£2	(RS Components, n.d.)
008	Durat light casing	5		Durat	Sub-contracted	Cast	£9	
010	PCB	5			Sub-contracted		£9.25	(RS Components, n.d.)
009	Bluetooth module	5			Supplied		£3.50	(RS Components, n.d.)
011	Battery	5	Molex		Supplied		£1.40	(RS Components, n.d.)
013	Branding Components	5		Bamboo	Sub-contracted	Laser cut	£0.50	
Total							**£93.84**	

Table 7: Component Sourcing Matrix (Bostock, 2021)

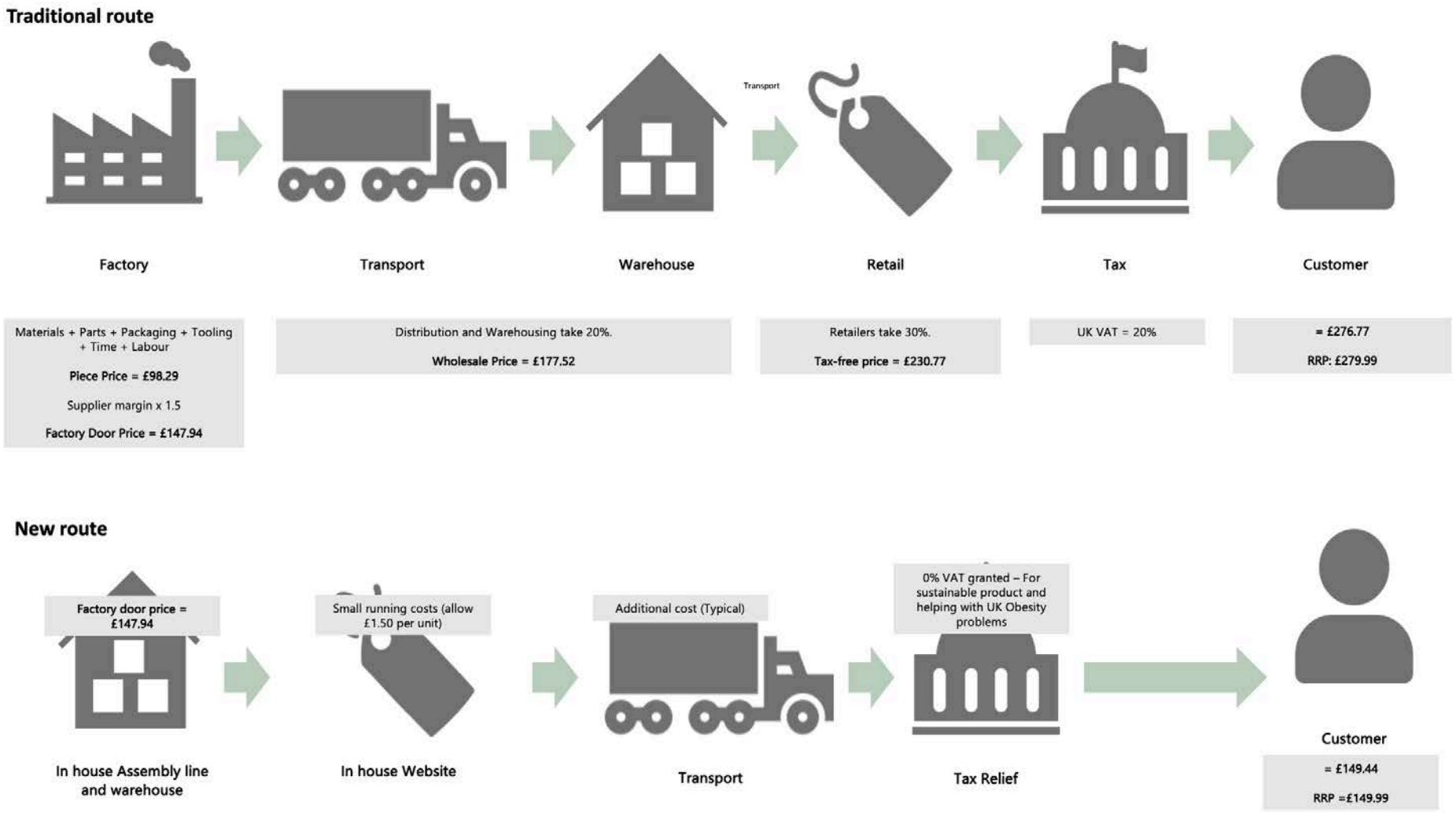


Figure 56: Business Case (Bostock, 2021)

3.6 EVALUATION

Specification point	Loading (3-5-7)	Score (1-5)	Total	Comments
Must be usable for children above the age of five with adult supervision	7	5	35	
Must use precision agriculture and therefore must include sensors to monitor crops	7	4	28	The lights are sensored to monitor external light sources.
Must include safety features such as electrical shut off systems	7	5	35	
Must be a compact size with a potential soil surface area in excess of 50cm^2 per day of growth	7	5	35	Each pot has a soil surface area of 56cm^2.
Must be ergonomically efficient	7	4	28	
Must be user maintainable – repairable	7	4	28	
Must be between £50-£150	7	5	35	The product retails at £149.99.
Must grow quick growing, nutritious and useful crops	7	5	35	
Must provide the family food for throughout the year, month and week	7	5	35	
Should mitigate long term injuries associated with gardening	5	5	25	
Should include materials which are sustainable and/or can be recycled and therefore ensuring an end of life plan	5	4	20	
Should include an irrigation system	5	1	5	The product does not have an irrigation system however this can be added in a later version of the product, this would be situated on the linear magnet casing.
Should assist the user in making optimal decisions for the health of the crop	5	3	15	
Should have a sophisticated aesthetic	5	5	25	
Should limit all carbon dioxide emissions throughout it's lifetime including during manufacture	5	4	20	
Should be a closed or partially closed eco-system	5	4	20	Partially closed – The leftover stems of the harvested crop decompose giving nutrition to the soil for the next seeds to sprout.
Could be a starter kit to change attitudes towards growing your own food at a manageable level first – educational tool	3	5	15	The product is a starter kit that encourages a change of attitude towards growing your own food.
Could include mobile or smart connectivity	3	5	15	The product connects to an app via a Bluetooth module.
Could make sequential farming easier for the user	3	5	15	
Could assist the with the growing problem of childhood obesity in the UK	3	5	15	
Total			484/550	

Table 8: Pugh Chart - Final Product Vs. Specification (Bostock, 2021)

CONCLUSION

The final project was to produce a product which encourages the uptake of home growing.

During the research, it was identified that urban environments are obesogenic because citizens struggle to source fresh and sustainably sourced food products. Foods eaten within UK urban environments have incredibly long food supply chains that contribute to environmental problems such as global warming. Global warming is going to get worse, therefore children need to learn the skills required to reduce the amount of CO_2 the planet emits. The final design provides an educational tool which urban parents can use to teach the art of growing and cooking your own food, removing the need for food transport. This tool will prove to both parents and children that it is easy and rewarding to produce a home-grown meal. Living in a smaller space does not mean you cannot grow your own food, HelloSprout proves that unused indoor and outdoor spaces are all suitable and can be used to great effect.

The product should spark an interest in the hobby and could persuade families to scale-up their home growing efforts to produce other fruits and vegetables and therefore increasing the overall sustainability and health of the family.

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APPENDICES

APPENDIX A: Timescale Planning GANTT Chart (Bostock, 2021)

APPENDIX B: Personal Log

Date (week beginning)	Personal Focus	Submission Contribution
17th May	This first week, I focused on gaining a depth of knowledge surrounding the subject of sustainable agriculture within industry as well as the home. This gave me background knowledge which it helped me to connect with the project. I needed this connection to be able to communicate my thoughts and design process and therefore make it easy for outsiders to quickly understand. I gathered my initial research in a separate document.	This week was mostly about gathering information to enable me to start the submission. However, I did tweak my timescale plan from the earlier planning submission and create the documents with appropriate headers to guide my process.
24th May	This week, I started to split out my initial research using the AEIOU framework. Once I did this, I found areas within my research that were not covered as much as others. I made sure that I completed these to ensure that I had a rounded research phase.	I started to create pages related to the AEIOU framework and a few context pages. I defined the design opportunity clearly using mind maps and a trend analysis. At this point, even with the prior research I felt still a little unclear about the project's direction, what benefits it will have and how it will convert people from alternatives. I took on Clive's advice after a tutorial and created a feedback loop to define this.
31st May	This week I focused on gaining insight into the user groups, particularly understanding their frustrations and why existing products aren't suitable. Why do families choose supermarkets over growing their own produce?	This week I started to gather the data from the questionnaire I sent out, I converted the results into appropriately chosen pie charts and bar charts. I then created a persona profile of a typical urban family and mapped the stakeholders this product would be affected by or would affect.
7th June	My personal focus this week was to understand whether any adjacent technologies could solve some of the issues identified within this project and whether there is any good ideas which could be adapted within existing products.	I mapped out the existing market for herb/garnish growing products to understand where the gaps are in the market. Also, I did some research into usability to understand common issues with gardening products and how we could reduce these within the product. I categorized this information and placed it into a formula for good usability.
14th June	This week, I wanted to converge my thoughts from the research phase and make key decisions which will form the basis of the ideation phase.	I started this week by researching what sort of aesthetic would be appropriate. This required to appeal to children, include sustainable materials and fit into the existing aesthetic within the family home. I gathered physical samples to understand what colours would complement the greens of the microgreens which will be grown. Then I created a design brief and specification to focus the rest of the design project to ensure that the outcome is research-led.
21st June	I used inspiration from the world around me to create some innovative thumbnail sketches to be evaluated against the specification.	I started to thumbnail sketch this week and understand what the stronger ideas were.

Date (week beginning)	Personal Focus	Submission Contribution
28th June	Diverging ideas using the specification as a focus to create innovative concepts.	I chose 4 concepts to be evaluated against the specification. I picked the best rated concept to be prototyped to understand the issues with it so they could be solved within development. I developed the idea through sketching, and it evolved to include magnets to increase seed germination and growth. There was a few issues at this stage deciding what magnets to use however due to safety issues and cost, linear magnets were chosen.
5th July	Create a realistic looking CAD model and renders to present my final major project. These need to persuade on-lookers to read more about my project at the degree show as well as being an appropriate proposal for the identified target audience.	I started the create the CAD model based upon my sketches, brand and aesthetic development. This took about three days as I based components on ones, I had found on the internet to reduce the time this took. After this, I exported the model to KeyShot to make realistic in-situ renders, to create the specific materials I wanted to use I had to use their cloud service to download specific materials.
12th July	Create a realistic looking CAD model and renders to present my final major project. These need to persuade on-lookers to read more about my project at the degree show as well as being an appropriate proposal for the identified target audience.	I used the Make2D function in Rhinoceros 3D to create detailed and scaled orthographic of the final product. I continued to create renders and pages which communicate my final idea within the journal, these will be copied and edited slightly to be placed within the presentation.
19th July	Creating accurate costs to see whether this idea is feasible and desirable for the target demographic.	The components within the final product were broken-down to produce a component list. From this, I created a detailed costing list which determined the RRP and the to market business route. The costings considered manufacturing methods/details, material, wage costs etc.
26th July	Using the assignment brief to make sure I have covered everything required as well as communicated this effectively throughout all the documents.	I used the last two weeks of the semester to finish all the remaining submission requirements. This included using the finished journal work to condense down to create the presentation. I also used this time to take my research notes and journal work to make the report contents. Throughout the project, I videoed important parts of the design process which will need to be gathered and edited together to create the 2-minute video.
2nd August	Using the assignment brief to make sure I have covered everything required as well as communicated this effectively throughout all the documents.	I used the last two weeks of the semester to finish all the remaining submission requirements. This included using the finished journal work to condense down to create the presentation. I also used this time to take my research notes and journal work to make the report contents. Throughout the project, I videoed important parts of the design process which will need to be gathered and edited together to create the 2-minute video. I was given a two-week extension for this module as I had to self isolate, but I only used a few days of this.

APPENDIX C: SUMMARY OF THE MAIN CLASSES OF PLANT HORMONES (BioNinja, n.d.)

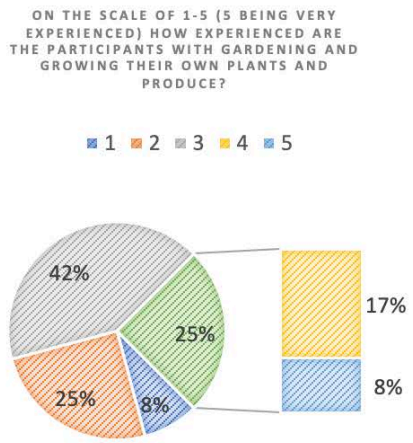




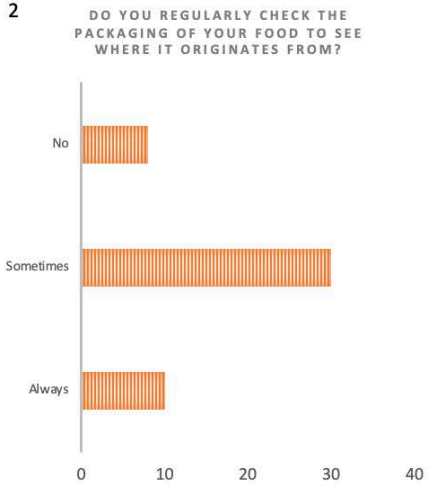

	Germination	Growth to Maturity	Flowering	Fruit Development	Abscission	Seed Dormancy
Gibberellin	✓	✓	✓	✓	✗	✗
Auxin	✗	✓	✓	✓	✗	✗
Cytokinins	✗	✓	✓	✓	✗	✗
Ethylene	✗	✗	✓	✓	✓	✗
Abscisic Acid	✗	✗	✗	✗	✓	✓

APPENDIX D: QUESTIONNAIRE RESULTS (Bostock, 2021)

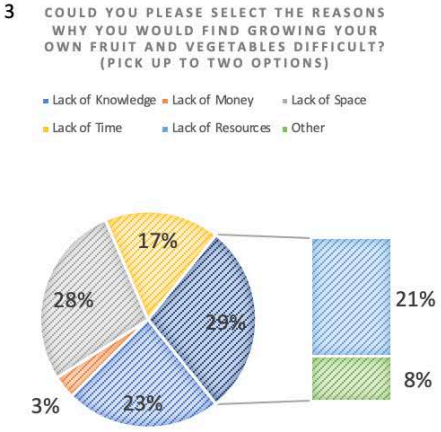
1



2



3



Only 8% of participants feel experienced growing food.

Not many of the participants felt that they were experienced with growing their own plants and produce. The majority of responses were 3, meaning they felt averagely competent with this skill.

This suggests that the design should take the complexity out of growing your own produce. This might be a factor which is putting off potential growers and if this can be mitigated or solved then we could persuade new people to participate in the activity.

Most participants check the origin of their food.

The data shows that the population cares about where their food comes from and the negative eco-impact this has however, they do not feel confident in growing their own food and solving this issue. If precise agriculture could be used to take the science away from growing your own food, this could increase uptake within these groups of people. Giving consumers a choice when it comes to sustainable food sourcing for their families.

The top reasons for difficulty when growing food are lack of knowledge and lack of space.

This evidence supports the need for a product to solve/mitigate growing food in urban areas where space is limited and is currently an inhibiting factor. The high percentage of responses stating lack of knowledge as a reason, reinforces the first question's analysis as well as proving that the science behind growing plants is too complex for most of the population.