

ATMOS - GEAR

Up-to-date environmental change and personal weather forecast device

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Definition of project

Problem statement

Adverse weather can put a dampener on any outdoor activity. Imagine, instead of arranging activities by time, we could accurately arrange them by the weather. Globally, weather is becoming more extreme and, in an age, where everything is personalised and at our fingertips there is a need for individual weather forecasts.

Project outcomes and aims

To create an accurate portable precipitation forecast device for the locality of an individual. Using data captured on atmospheric pressure, temperature, humidity, and predicted local forecast create an accurate device that communicates with the user to indicate adverse weather e.g., rain, snow, and hail.

Needs:

- To detect a change in weather accurately
- To be used in a static and portable state sufficiently
- To be easy to read and understand
- To have a battery life of 7 days+
- To withstand extreme climates, e.g., snow
- To be waterproof
- To withstand a drop of 2 meters
- To store enough personal data to make strong predictions
- To be light weight, and easy to carry

Validation of product



We have all encountered a time where the weather has forced us to change plans or cancel them altogether. At a time where modern technology is all around us why can't we be sure the weather isn't going to spoil our plans. If in an ideal world we could be certain when it was going to rain, snow or hail we could plan accordingly. For example, go for a dog walk before dinner because you know you have enough time to walk the dog before it rains, you could then enjoy dinner knowing you don't have to walk in the rain. If the whole family is free and you want to decide whether to do an indoor or outdoor activity you could rely on your personal weather forecast. If you were a farmer with cattle outside and you need at least 30 minutes to bring them inside before it rains, you could do so by viewing your weather forecast. All of these scenes above could have been avoided.

The national weather forecasting system is a useful tool but there are certain features it doesn't have that would be hard to implement on a national scale in this format, see fig 6.

This includes:

- Data captured for specific local areas and available to individuals
- Specific area predictions
- Instant up-date on temperature, pressure and humidity
- 24/7 warning for unwelcomed weather



Uk national weather Sunday 14 June (Met Office, 2020)

Weather forecasting apps have become very popular with it coming as a standard on every new smart phone. It is estimated 92% of adults who live in the uk have a smartphone and 95% of people who own a smartphone use their phone every day. However, local forecasting app also have features that would be useful, but they don't include as a standard.



Uk national weather Sunday 14 June (Met Office, 2023)

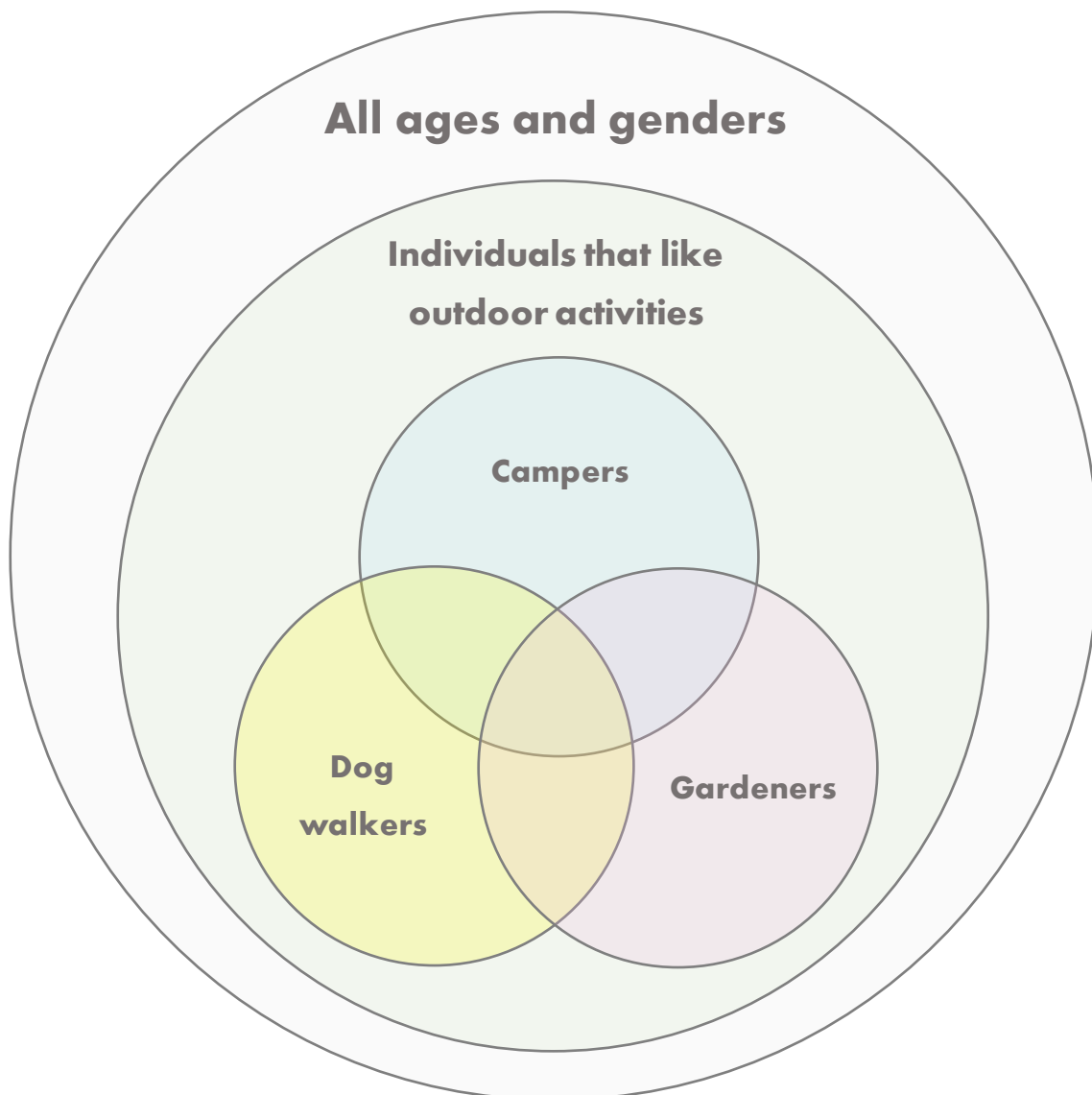
This includes:

- Data on pressure and humidity
- 24/7 warning function for unwelcomed weather

Weather forecasts are also known for not always being correct, scaling down the area and having constant monitoring can improve predictions.

This project aims to be the next development in weather forecasting. Making it personalised will hopefully encourage individuals to take more interest in weather changes and will allow people more control over events. Even though we can open up the weather app or watch the weather forecast on tv to check the weather we are still going outside when its dry and returning soaked from the rain. This can put a lot of people off going outside, if there was a system we could rely on more people may go outside more often. Going outside can be beneficial for our health and our social happiness.

Target market



My design is not going to be age or gender specific. I want it to appeal to as many people as possible. Due to the idea being fully focused on monitoring and alerting changes in weather, it will target people that perform outdoor activities. For now, I am going to narrow this down to three different sectors: dog walkers, campers and gardeners. I want my product to be applicable to almost and if not everyone. For the time being I would like to target these certain groups with the hope of creating a unit that can be switched between bodies to be suitable to each activity or a unit that fulfils everyone's needs.

Option 1

Modular unit to
have changeable
bodies

Option 2

Unit suitable for all
targeted activities

Exploration, investigation and specification

Products available on the market

A black rectangular weather station with a large LCD screen displaying weather icons and data. It has several buttons at the bottom and a small antenna on top.

DIGOO-Wireless weather station

Durability-	4
Usability-	8
Portability-	2
Features-	9
Accuracy-	7
Overall-	30

A glass sphere on a metal stand, containing a liquid and floating objects that change shape based on weather conditions. It is placed on a wooden surface next to a vase of flowers.

Storm glass

Durability-	8
Usability-	7
Portability-	1
Features-	2
Accuracy-	2
Overall-	20

A white cylindrical weather station with a digital display and a smartphone connected to it via a cable.

NATATMO by Google

Durability-	9
Usability-	7
Portability-	2
Features-	9
Accuracy-	8
Overall-	35

A white smartphone displaying a weather app interface, with a small circular weather station device next to it.

Tempo Disco

Durability-	8
Usability-	9
Portability-	10
Features-	7
Accuracy-	8
Overall-	42

DIGOO-Wireless weather station

Pros

- Easy to read and understand
- Modern, fits into the home environment
- National weather forecast, comfortability levels, humidity, temperature, and pressure, date and time

Cons

- Not portable
- Doesn't save data to personalize weather forecast
- Outside monitor can flood affecting humidity reading
- Low accuracy e.g. temperature +/- 1degree

Storm glass

Pros

- Easy to read and understand
- Unique form
- Interactive
- Portable to a degree
- Different styles to suit all, the same principle
- Cheap

Cons

- Not accurate
- Not scientific
- Doesn't record temperature, humidity, or pressure

NATATMO by google

Pros

- Easy to read and understand
- Stylish
- Can access anywhere
- Inside and outside the station
- Humidity, temperature, and pressure, date and time
- Long-life battery

Cons

- Costs a lot (£450)
- Doesn't save data to personalize weather forecast

Tempo Disco

Pros

- Easy to read and understand
- Stylish
- Can access anywhere
- Humidity, temperature, and pressure, date and time
- Very portable
- Long-life battery
- Saves data

Cons

- Can get lost
- Can't attach it to bag
- Will be put in pocket and won't be accurate

What to take forward:

The display screen of the DIGOO- big, clear, simple infographics

The modern design of the NATATMO- silver, clean, straight lined no visible buttons

The nano technology of the tempo disco- smaller the technology = smaller design, pocket sized

Bear in mind price as target market is wide, needs to be affordable for all

Day in the life of product

Commonalities in all 3 products

Each object is used outside

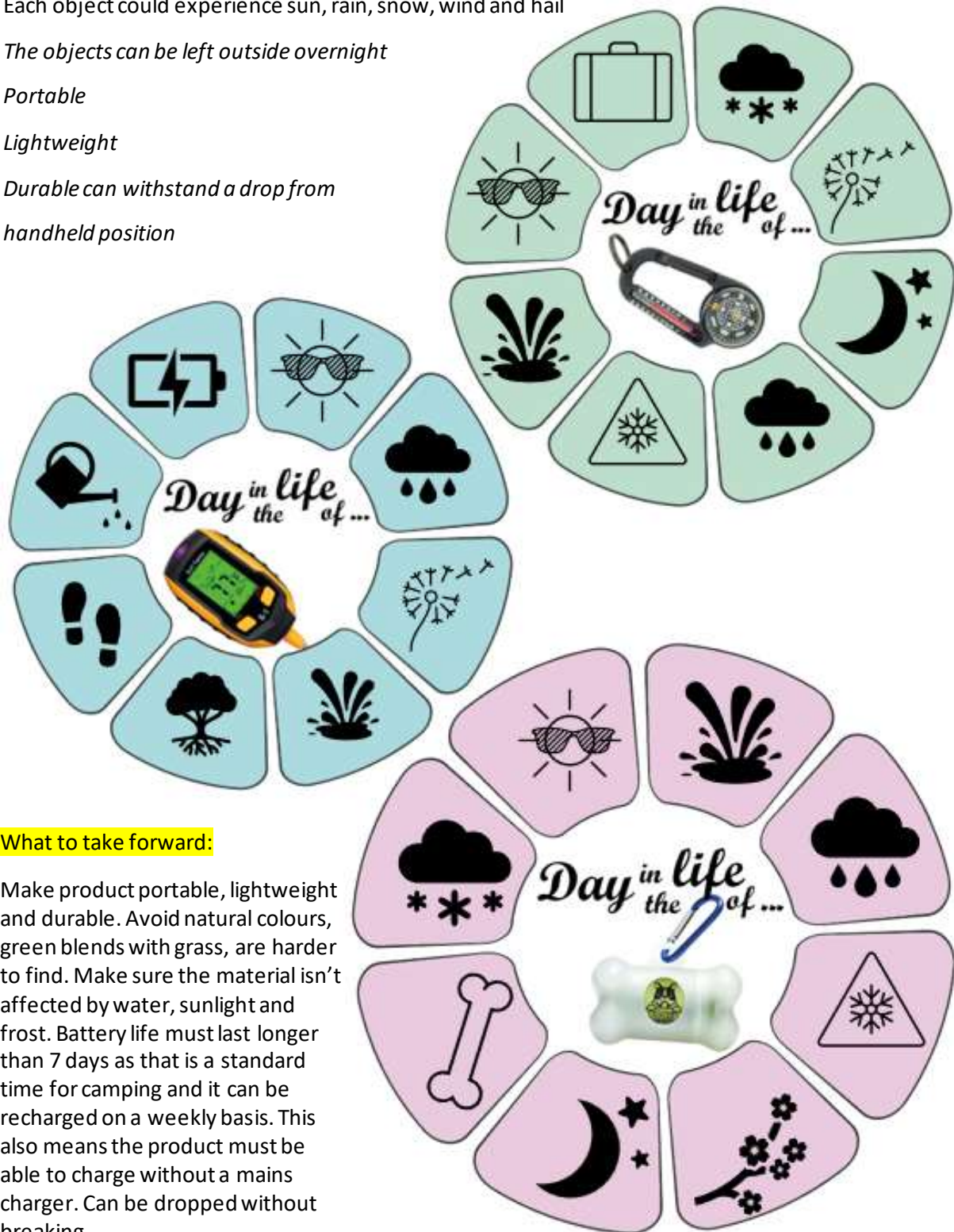
Each object could experience sun, rain, snow, wind and hail

The objects can be left outside overnight

Portable

Lightweight

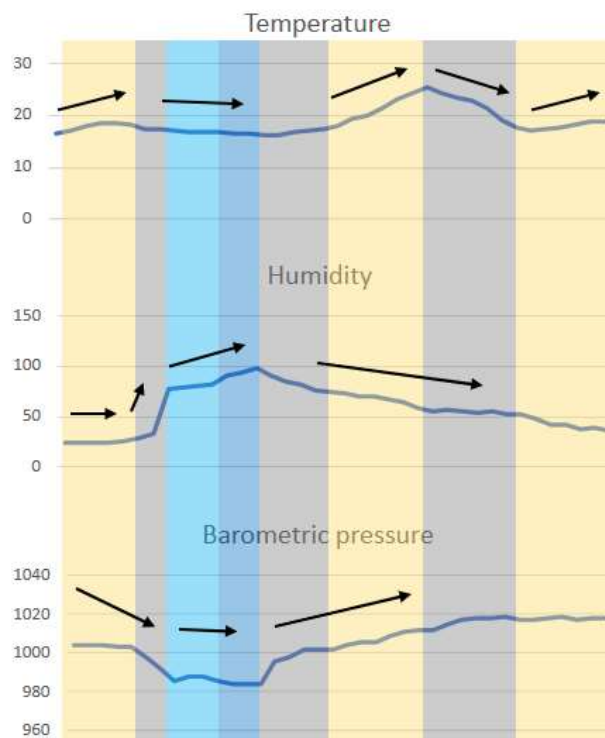
*Durable can withstand a drop from
handheld position*



What to take forward:

Make product portable, lightweight and durable. Avoid natural colours, green blends with grass, are harder to find. Make sure the material isn't affected by water, sunlight and frost. Battery life must last longer than 7 days as that is a standard time for camping and it can be recharged on a weekly basis. This also means the product must be able to charge without a mains charger. Can be dropped without breaking.

Theory of weather change



An increase in pressure = Decrease in humidity
An increase in humidity = Precipitation

Findings

Temperature, pressure, humidity, real-time weather, and weather forecast were recorded simultaneously. All data is supportive of my theory. There is a correlation between temperature, pressure, and humidity. Therefore an algorithm can be created to use data on temperature and pressure to predict humidity and therefore inform it is likely to rain.

Observations:

Before it rained humidity started to increase, pressure started to increase, and the temperature stayed the same.

During the rain, the temperature dropped. Pressure decreased the rain stopped.

After the rain humidity slowly started to fall and the temperature began to rise during the daylight hours. Pressure remained the same

AMTAST Barometer Altimeter Thermometer Weather Forecast Monitor for Climbing Camping Outdoor Sports, Multi-Function with Backlight

★★★★☆

About this item

- Barometer & Altimeter: The **air pressure** value on the screen is the air pressure at the **current location**. The height value on the screen is the **sea level** of the current location. Press [ALTI/+] button to switch the use of altimeter and barometer.
- Relative Altitude: Monitor the ascending or descending altitude from one certain location or the relative altitude for any mountain or object etc.
- Weather Forecast: Apart from detecting the altitude, barometer also helps to **forecast the weather** for the forthcoming **12 to 24 hours** basing on barometric pressure changes. The effective range is **30-50kms**.
- History Altitude Record**: Press [HISTORY] button, you can view records of history altitude and **air pressure**. It will display the most previous record in this mode, then you can press [ALTI/+] or [-] button to forwards or backwards view history records. It can save most **256pcs records**, the records' distance are five minutes, and you can change the distance from **1-60 minutes** if you press and hold [HISTORY] button for 2 seconds.
- Save power design: When you don't want to use the device, you press and hold [SET] button for 5 seconds, the device will stop all display enter into dormancy mode. And then you press any button, it will resume previous display. Backlight: In any mode, it can give you backlight for 5 seconds that you press any button.

£19.99



Comments

Wildly inaccurate device when using as an altimeter. Depending on the temperature the level of my garden varied between 115m to 175metres above sea level according to this device. Sometimes it read 115m and then I'd check it later and the device would read 175m and could vary between these figures. I'd bought the device for height readings and so its inaccuracy made it useless for me. I've thrown it in the bin, a waste of £18.

Does the job. Does not read altitude, works off pressure so if u have high pressure u have a wrong reading. Probably worst product I've ever bought off Amazon. Battery lock does not have any water proofing. Don't pay good money for this

Is not accurate. inaccurate. Hard to read but eventually worked out the functions.

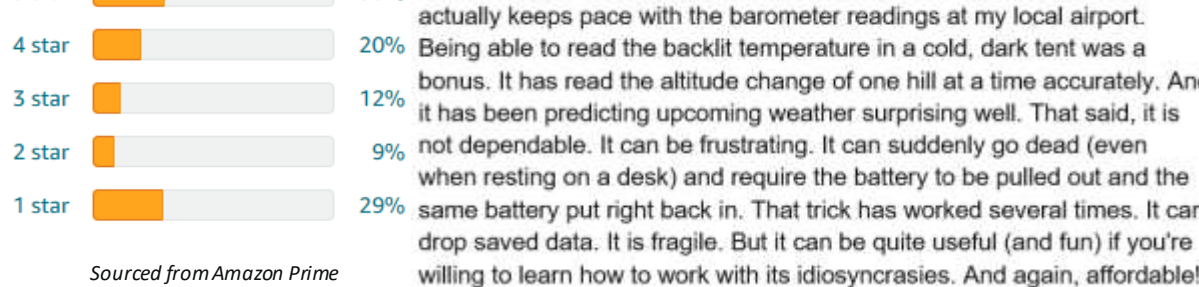
The altimeter is a good 500-600 ft off. My buddies hike with serious GPS and this one is not accurate. Since the altimeter is off I'm unsure if the rest of it is accurate.

Altitude and humidity are always inaccurate. Thermometer works decent would not recommend

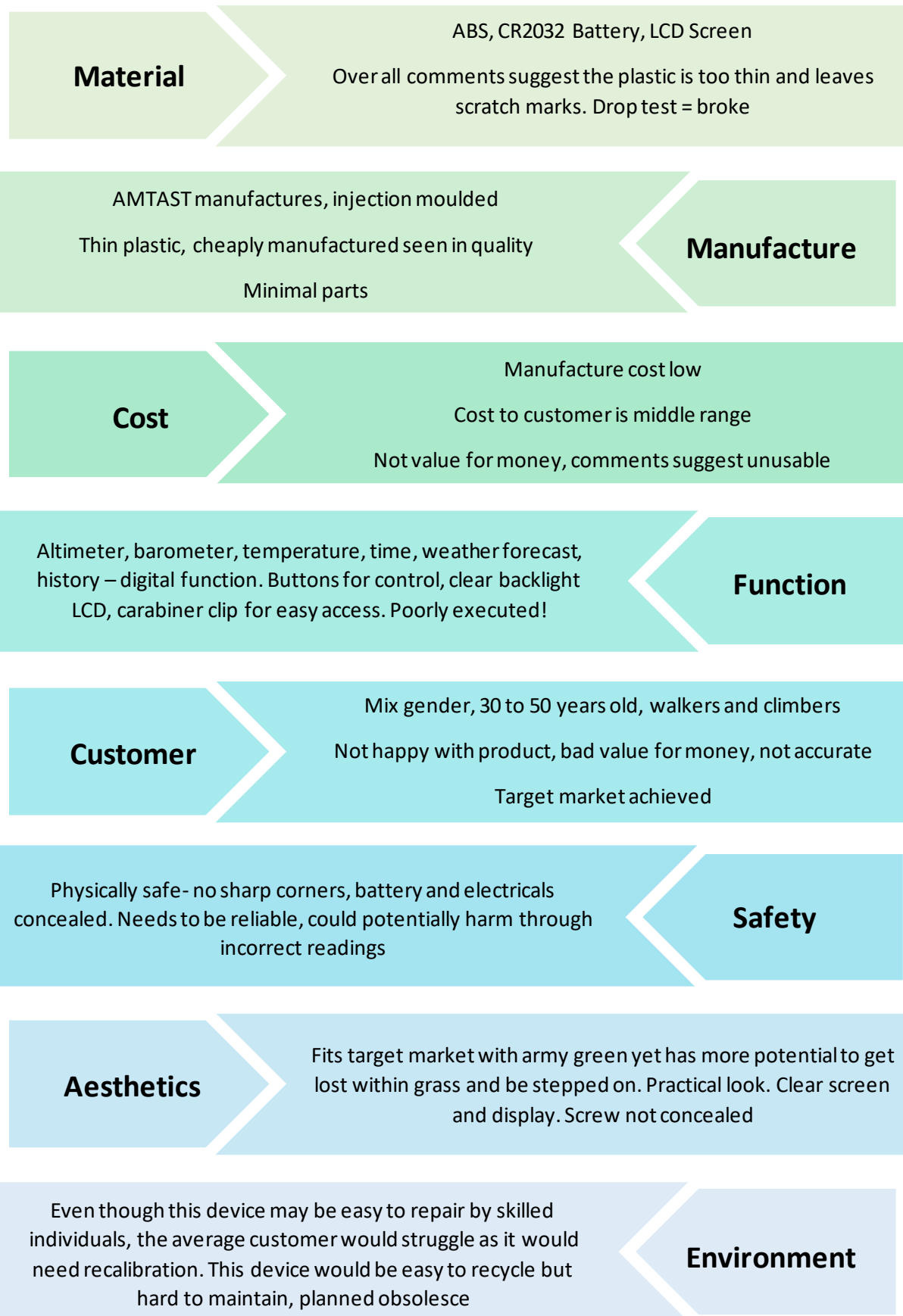
I used the product on my golf bag. It gave me what I was looking for. no battery included.

Pretty neat little Gadget. When this thing works, it's helpful. easy to attach to my backpack

Poor durability. Visible scratches around lcd display after first use, seemed to be made cheap materials



Sourced from Amazon Prime



Outcome of product analysis

What to take forward:

Appropriately sized display screen

Buttons? Make sure they are big enough

Easy to use, used instinctively, DON'T OVERCOMPLICATE

Use appropriate material, don't make item flimsy, good weight, consider ABS

Keep manufacturing cheap, not at a cost to quality

Value for money is key

Needs to have high level of accuracy

Functions should include Altimeter, barometer, temperature, time, weather forecast, history

DON'T USE CAMO COLOURS!

Consider repairability, repairability and longevity = quality

Deconstruction of existing product





What to take forward:

Keep parts to a minimum

Screw fixtures are good for maintaining but can leak in water

Make 2 sides of body to fit together

Injection moulding worked well – make sure it's designed for hidden pin slots

No sharp corners

Electrical components are neatly organised with device

Don't leave too much air gap as make part flimsy

Use images, less text on instruction

Components required

Computer

"Raspberry Pi and Arduino are two very popular boards among electronics DIY builders, hobbyists and even professionals. Raspberry Pi and Arduino are quite different boards. While Arduino is aimed at quick programming and circuit prototyping, Raspberry Pi acts as a learning tool for Computer Programming (but you can find Raspberry Pi in several DIY Projects as well). Each board has its own advantages and disadvantages" (Electronics hub, 2022).

- The main difference between them is Arduino is microcontroller board, while Raspberry Pi is a microprocessor based minicomputer (SBC).
- The Microcontroller on the Arduino board contains the CPU, RAM and ROM. All the additional hardware on Arduino Board is for power supply, programming and IO Connectivity. Raspberry Pi SBC has all features of a computer with a processor, memory, storage, graphics driver, connectors on the board.
- Raspberry Pi needs an Operating System to run. Arduino doesn't need any operating system. All you need is a binary of the compiled source code.
- Raspberry Pi comes with a fully functional operating system called Raspberry Pi OS (previously known as Raspbian OS). Although Pi can use different operating systems, Linux is preferred by Raspberry Pi Foundation. You can install Android if you want. Arduino does not have any operating system. You just need firmware instructing the Microcontroller on what task to do.
- The clock speed of Arduino is 16 MHz while the clock speed of Raspberry Pi is around 1.2 GHz.
- Raspberry Pi is good for developing software applications using Python, while Arduino is good for interfacing Sensors and controlling LEDs and Motors.

All information on Arduino and Raspberry pi is taken from Electronics hub, 2022 ([What are the differences between Raspberry Pi and Arduino? \(electronicshub.org\)](https://www.electronicshub.org/what-are-the-differences-between-raspberry-pi-and-arduino/)) and confirmed by other sources



After researching Arduino and raspberry pi, I have decided to conduct my first stages of prototyping using raspberry pi and using the coding language of python.

My final stages of prototyping will include an Arduino. The change is due to using what resources I currently have before moving to a more expensive, more accurate Arduino Nano.

	Arduino Uno Rev3	Arduino Nano 33 BLE with headers
		
Microcontroller	ATmega328P	nRF52840
Operating Voltage (v)	5	3.3
Limit of input Voltage (v)	12	21
Flash memory	32KB	1MB
DC current per I/O pin (mA)	20	15
Length (mm)	68.6	45
Width (mm)	53.4	18
Weight (g)	25	5

Battery

Lithium coin battery

- Needs replacing
- Lasts 30 days of use
- 20mm x 3.2mm



Lithium ion battery

- Rechargeable
- Lasts 12 hours of solid use (<2 hours per day for a week)
- 56mm x 6mm



AAA battery

- Needs replacing
- Lasts 4 months



Gauges and sensors

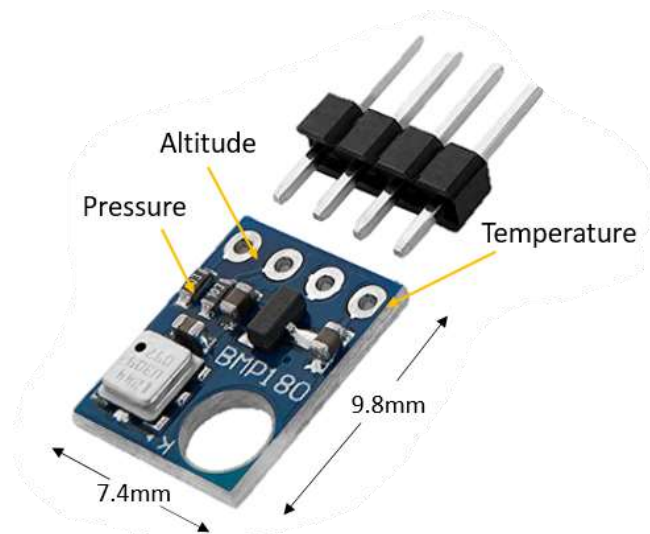
This can be connected to a raspberry pi to test for altitude, pressure and temperature.

A separate sensor for humidity will be needed to make the basic circuit for my product.

Based on what outcome is achieved will decide what my next steps are for further prototyping.

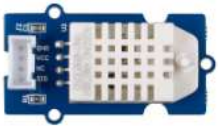
If successful, (fits within tolerances and displays correct predictions) this will be placed inside the final prototype.

If unsuccessful, single units of sensors will be used with an Arduino unit.



Sensors available for Arduino:

	Grove - Touch Sensor It can detect the change in capacitance when a finger is nearby. This means no matter if your finger directly touches the pad or just stays close to the pad, the Grove - Touch Sensor will output HIGH.	€4,40 ADD TO CART QUICK SHOP
	Grove - Temperature Sensor The resistance of a thermistor will increase when the ambient temperature decreases. It's this characteristic that we use to calculate the ambient temperature. The detectable range of this sensor is -40 - 125°C, and the accuracy is ±1.5°C	€3,30 ADD TO CART QUICK SHOP
	Grove - Sunlight Sensor This device is based on SI1145, a new sensor from SiLabs. The SI1145 is a low-power, reflectance-based, infrared proximity, UV index and ambient light sensor with I2C digital interface and programmable-event interrupt output. This device offers excellent performance under a wide dynamic range and... View full details	€12,30 ADD TO CART QUICK SHOP

	Grove - Gas Sensor (MQ3) It is suitable for detecting Alcohol, Benzine, CH4, Hexane, LPG, CO. Due to its high sensitivity and fast response time, measurements can be taken as soon as possible. The sensitivity of the sensor can be adjusted by using the potentiometer. Note: The sensor value only reflects the approximated ... View full details	€13,77 NOTIFY WHEN AVAILABLE
	Grove - Alcohol Sensor It is built with MQ303A semiconductor alcohol sensor. It has good sensitivity and fast response to alcohol, making it suitable for building a breathalyzer. This Grove module implements all the necessary circuitry for the MQ303A, such as power conditioning and heater power supply. This sensor outp... View full details	€7,93 NOTIFY WHEN AVAILABLE
 SAVE 24%	Grove - Temperature & Humidity Sensor Pro Grove-Temperature & Humidity Sensor Pro is a high accuracy temperature and humidity sensor based on the DHT22 module (also known as AM2302 or RHT03). High-cost performance and high precision make it ideal for temperature and humidity monitoring of Arduino and Raspberry Pi, you can also use it... View full details	€11,20 €8,47 ADD TO CART QUICK SHOP
	Grove - Temperature & Humidity Sensor (SHT31) The sensor(chip) used in the module is designed with Sensirion's CMOSens® technology. The chip is well calibrated, linearized and compensated for digital output. The typical accuracy of this module can be ±2%RH (for relative humidity) and ±0.3°C (for temperature). This module is compatible with ... View full details	€13,40 ADD TO CART QUICK SHOP
	Grove - Temperature & Humidity Sensor This is a multifunctional sensor that gives you temperature and relative humidity information at the same time. It utilizes a TH02 sensor that can meet measurement needs of general purposes. It provides reliable readings when environment humidity condition inbetween 0-80% RH, and temperature con... View full details	€12,90 ADD TO CART QUICK SHOP
	Grove - Temp & Humi & Barometer Sensor (BME280) This module can be used to measure temperature, atmospheric pressure and humidity accurately and fast. As the atmospheric pressure changes with altitude, it can also measure approximate altitude of a place. It can be connected to a microcontroller with I2C (integrated with Grove socket) or through... View full details	€19,90 ADD TO CART QUICK SHOP
 SAVE 23%	Grove - Moisture Sensor This sensor is very simple to use, you insert in into the soil and read the data. With this sensor in the right project, your plants can let you know when it's time to water them. Features: Soil moisture sensor based on soil resistivity measurement Easy to use 2.0 cm X 6.0 cm grove module	€5,90 €4,52 ADD TO CART QUICK SHOP



Grove - Barometer Sensor (BMP280)

€10,00

It can widely measure pressure ranging from 300 mbar to 1200 mbar, with a super high accuracy of 0.01mbar(0.1m) in ultra-high resolution mode. The chip only accepts 1.8V to 3.6V input voltage. However, with the outer circuit on the pcb added, this module becomes compatible with 3.3V and 5V. There...

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Grove - Air quality sensor v1.3

€12,00 **€7,53**

This sensor is designed for comprehensive monitor over indoor air condition. It's responsive to a wide scope of harmful gases, as carbon monoxide, alcohol, acetone, thinner, formaldehyde and so on. Due to the measuring mechanism, this sensor can't output specific data to describe target gases' co...

[View full details](#)

NOTIFY WHEN AVAILABLE



Grove - 80cm Infrared Proximity Sensor

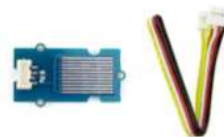
€15,80

This sensor SharpGP2Y0A21YK, boasts a small package and very low current consumption, takes a continuous distance reading and returns a corresponding analog voltage with a range of 10cm (4") to 80cm (30"). It can be used in TVs, personal computers, cars and so on. Features: Grove interface co...

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Grove - Water Sensor

€3,50

The sensor traces have a weak pull-up resistor of 1 MΩ. The resistor will pull the sensor trace value high until a drop of water shorts the sensor trace to the grounded trace. Believe it or not this circuit will work with the digital I/O pins of your Arduino or you can use it with the analog pins...

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Multi-function Environmental Module - CCS811+BME280

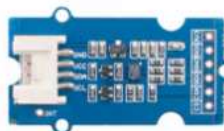
€31,80

Build up a simple environmental monitor station with this multi-function environment sensor! Based on the combination of CCS811+BME280 chip, this module features high accuracy, I2C interface, and fast Measurement. The BME280 can provide temperature and humidity compensation for CCS811 to improve...

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Grove - High Precision Barometric Pressure Sensor (DPS310)

€8,80 **€7,53**

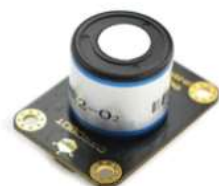
Grove - DPS310 is a high precision barometric pressure sensor, it can measure air pressure change caused by height changes in the centimeter level. Typical Applications: Indoor Navigation (floor detection e.g. in shopping malls and parking garages) Health and Sports (accurate elevation gain ...

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SAVE 14%



Gravity: I2C Oxygen Sensor

€54,50

The Gravity: I2C Oxygen Sensor is based on electrochemical principles and it can measure the ambient O2 concentration accurately and conveniently. With high anti-interference ability, high stability and high sensitivity, this arduino-compatible oxygen sensor can be widely applied to fields like ...

[View full details](#)

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QUICK SHOP

User interaction components

Option 1:

LED coloured traffic light system.
Each colour would indicate a specific time range for when it is next going to rain e.g., green is not soon, amber is within 10 minutes and red is raining.



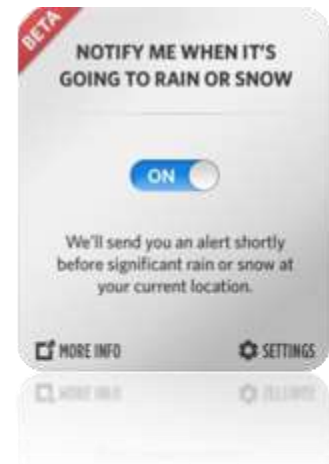
Option 2:

An LCD screen communicates when it is going to rain, hail, or snow to the user.



Option 3:

An app connected to the sensors notifies you when it is going to rain, hail, or snow and can let the user see data collected using the sensors.



Option 4:

A mixture of two options, most likely the app and LEDs as the user can view previous data and the LEDs are the lowest energy consumption option and will do the same job as an LCD screen.

Components selected

	Possible components for end product			
Computer	Arduino mini			
Battery	Lithium Ion rechargeable	AAA batteries	Lithium coin battery	
Sensors	Humidity	Pressure	Temperature	Altitude
Secondary sensors	Sunlight	Air quality	Touch	Oxygen
interactions	LED	Mobile app	LCD	

Dimensions of internal parts

Largest possible components:

3 x AAA batteries

Arduino uno

7 x sensors

Roughly equals 70 x 54 x 45 mm

Smallest possible volume:

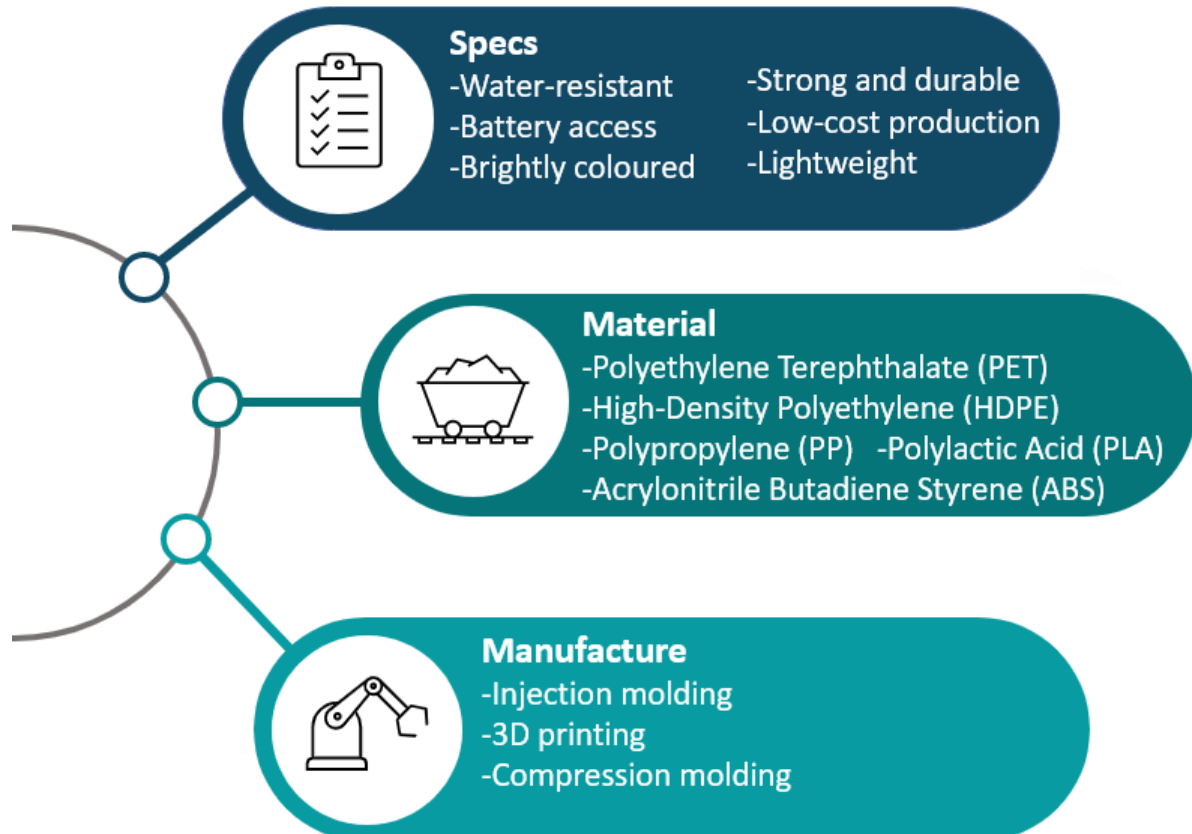
1 x lithium coin

Arduino nano

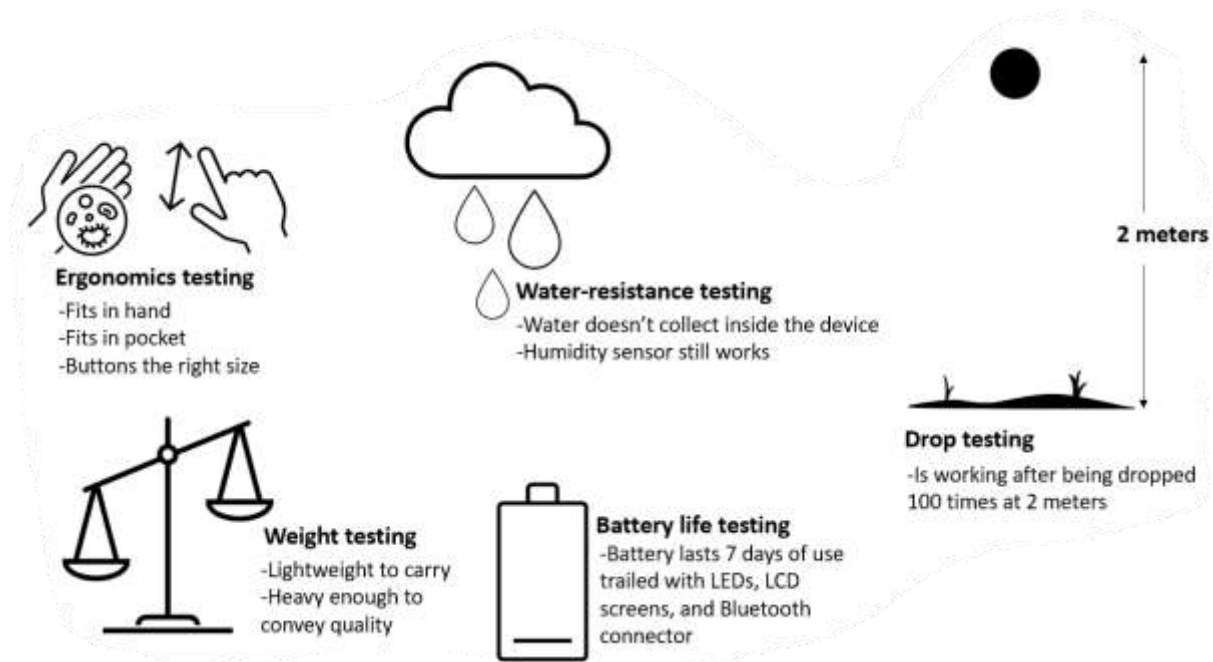
3 x sensors

Roughly equals 45 x 18 x 22 mm

Material and manufacture



Product testing



What to take forward:

Product in pocket or bag may not get accurate readings

Can be transported in bag or pocket

Must be comfortable to hold in hand

Must detect water, let water into sensor but doesn't destroy circuit

Must withstand 2m drop to prove quality (2m decide based on average human height and height on top of backpack)

Test for comfortable weight in hand and pocket, ideal phone weight is between 140g and 170g

Battery needs to be sufficient as device may be relied on

Want it slightly lighter – the result of testing with weights

Legislation

General Data Protection Regulation (GDPR)

Personal data — Personal data is any information that relates to an individual who can be directly or indirectly identified. Names and email addresses are obviously personal data. Location information, ethnicity, gender, biometric data, religious beliefs, web cookies, and political opinions can also be personal data. [Pseudonymous](#) data can also fall under the definition if it's relatively easy to ID someone from it.

Data processing — Any action performed on data, whether automated or manual. The examples cited in the text include collecting, recording, organizing, structuring, storing, using, erasing... so basically anything.

Data subject — The person whose data is processed. These are your customers or site visitors.

Data controller — The person who decides why and how personal data will be processed. If you're an owner or employee in your organization who handles data, this is you.

Data processor — A third party that processes personal data on behalf of a data controller. The GDPR has special rules for these individuals and organizations. They could include cloud servers like [Tresorit](#) or email service providers like [Proton Mail](#).

When you're allowed to process data

[Article 6](#) lists the instances in which it's legal to process person data. Don't even think about touching somebody's personal data — don't collect it, don't store it, don't sell it to advertisers — unless you can justify it with one of the following:

1. The data subject gave you specific, **unambiguous consent** to process the data. (e.g. They've opted in to your marketing email list.)
2. Processing is necessary to execute or to prepare **to enter into a contract** to which the data subject is a party. (e.g. You need to do a background check before leasing property to a prospective tenant.)
3. You need to process it **to comply with a legal obligation** of yours. (e.g. You receive an order from the court in your jurisdiction.)
4. You need to process the data **to save somebody's life**. (e.g. Well, you'll probably know when this one applies.)
5. Processing is necessary **to perform a task in the public interest** or to carry out some official function. (e.g. You're a private garbage collection company.)
6. You have a **legitimate interest** to process someone's personal data. This is the most flexible lawful basis, though the "fundamental rights and freedoms of the data subject" always override your interests, especially if it's a child's data. (It's difficult to give an example here because there are a variety of factors you'll need to consider for your case. The UK Information Commissioner's Office provides helpful guidance [here](#).)

Consent

There are strict new rules about what constitutes [consent from a data subject](#) to process their information.

- Consent must be “freely given, specific, informed and unambiguous.”
- Requests for consent must be “clearly distinguishable from the other matters” and presented in “clear and plain language.”
- Data subjects can withdraw previously given consent whenever they want, and you have to honor their decision. You can't simply change the legal basis of the processing to one of the other justifications.
- Children under 13 can only give consent with permission from their parent.
- You need to keep documentary evidence of consent.

Below is a rundown of data subjects' privacy rights:

1. The right to be informed
2. The right of access
3. The right to rectification
4. The right to erasure
5. The right to restrict processing
6. The right to data portability
7. The right to object
8. Rights in relation to automated decision making and profiling.

Code of practise for consumer internet of things security

Guidelines

1) No default passwords

All IoT device passwords shall be unique and not resettable to any universal factory default value.

Many IoT devices are being sold with universal default usernames and passwords (such as 'admin, admin') which are expected to be changed by the consumer. This has been the source of many security issues in IoT and the practice needs to be eliminated. Best practice on passwords and other authentication methods should be followed.⁵

Primarily applies to:

Device Manufacturers

⁵ For guidance see, for example: NCSC, 2016, 'Password Guidance: Simplifying Your Approach', <https://www.ncsc.gov.uk/guidance/password-guidance-simplifying-your-approach>. Also see: NIST, 2017, 'NIST Special Publication 800-63B: Digital Identity Guidelines - Authentication and Lifecycle Management', <https://pages.nist.gov/800-63-3/sp800-63b.html#sec5>

4) Securely store credentials and security-sensitive data

Any credentials shall be stored securely within services and on devices. Hard-coded credentials in device software are not acceptable.

Reverse engineering of devices and applications can easily discover credentials such as hard-coded usernames and passwords in software. Simple obfuscation methods also used to obscure or encrypt this hard-coded information can be trivially broken. Security-sensitive data that should be stored securely includes, for example, cryptographic keys, device identifiers and initialisation vectors. Secure, trusted storage mechanisms should be used such as those provided by a Trusted Execution Environment and associated trusted, secure storage.

5) Communicate securely

Security-sensitive data, including any remote management and control, should be encrypted in transit, appropriate to the properties of the technology and usage. All keys should be managed securely.

The use of open, peer-reviewed internet standards is strongly encouraged.

6) Minimise exposed attack surfaces

All devices and services should operate on the 'principle of least privilege'; unused ports should be closed, hardware should not unnecessarily expose access, services should not be available if they are not used and code should be minimised to the functionality necessary for the service to operate. Software should run with appropriate privileges, taking account of both security and functionality.

The principle of least privilege is a foundation stone of good security engineering, applicable to IoT as much as in any other field of application.

7) Ensure software integrity

Software on IoT devices should be verified using secure boot mechanisms. If an unauthorised change is detected, the device should alert the consumer/administrator to an issue and should not connect to wider networks than those necessary to perform the alerting function.

The ability to remotely recover from these situations should rely on a known good state, such as locally storing a known good version to enable safe recovery and updating of the device. This will avoid denial of service and costly recalls or maintenance visits, whilst managing the risk of potential takeover of the device by an attacker subverting update or other network communications mechanisms.

8) Ensure that personal data is protected

Where devices and/or services process personal data, they shall do so in accordance with applicable data protection law, such as the General Data Protection Regulation (GDPR) and the Data Protection Act 2018. Device manufacturers and IoT service providers shall provide consumers with clear and transparent information about how their data is being used, by whom, and for what purposes, for each device and service. This also applies to any third parties that may be involved (including advertisers). Where personal data is processed on the basis of consumers' consent, this shall be validly and lawfully obtained, with those consumers being given the opportunity to withdraw it at any time.

This guideline ensures that:

- i. IoT manufacturers, service providers and application developers adhere to data protection obligations when developing and delivering products and services;
- ii. Personal data is processed in accordance with data protection law;
- iii. Users are assisted in assuring that the data processing operations of their products are consistent and that they are functioning as specified;
- iv. Users are provided with means to preserve their privacy by configuring device and service functionality appropriately.

11) Make it easy for consumers to delete personal data

Devices and services should be configured such that personal data can easily be removed from them when there is a transfer of ownership, when the consumer wishes to delete it and/or when the consumer wishes to dispose of the device. Consumers should be given clear instructions on how to delete their personal data.

IoT devices may change ownership and will eventually be recycled or disposed of. Mechanisms can be provided that allow the consumer to remain in control and remove personal data from services, devices and applications.

12) Make installation and maintenance of devices easy

Installation and maintenance of IoT devices should employ minimal steps and should follow security best practice on usability. Consumers should also be provided with guidance on how to securely set up their device.

Security issues caused by consumer confusion or misconfiguration can be reduced and sometimes eliminated by properly addressing complexity and poor design in user interfaces. Clear guidance to users on how to configure devices securely can also reduce their exposure to threats.

13) Validate input data

Data input via user interfaces and transferred via application programming interfaces (APIs) or between networks in services and devices shall be validated.

Systems can be subverted by incorrectly formatted data or code transferred across different types of interface. Automated tools are often employed by attackers in order to exploit potential gaps and weaknesses that emerge as a result of not validating data. Examples include, but are not limited to, data that is:

- i. Not of the expected type, for example executable code rather than user inputted text.
- ii. Out of range, for example a temperature value which is beyond the limits of a sensor.

(2,3,9 and 10 do not apply)

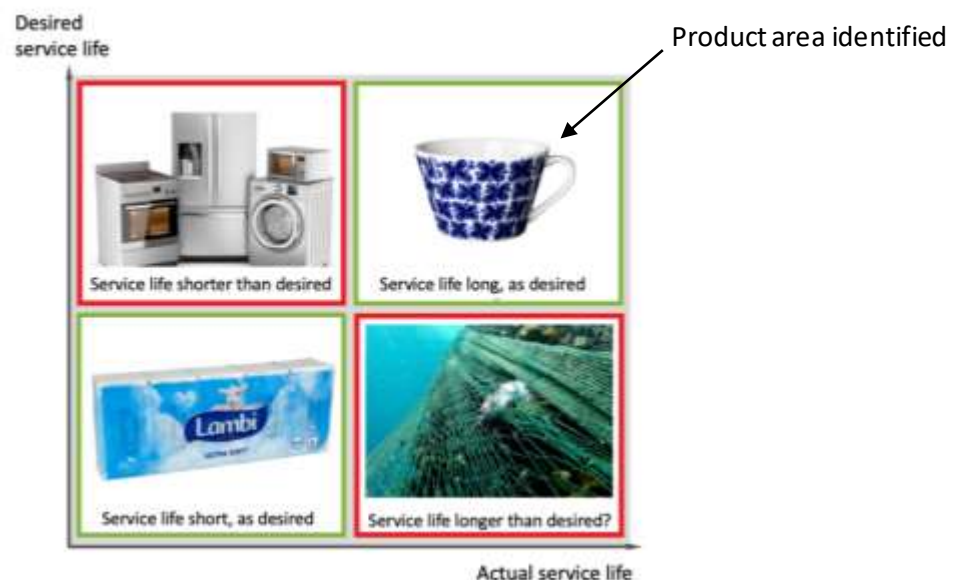
Repairability

What are the objectives of the Right to Repair movement?

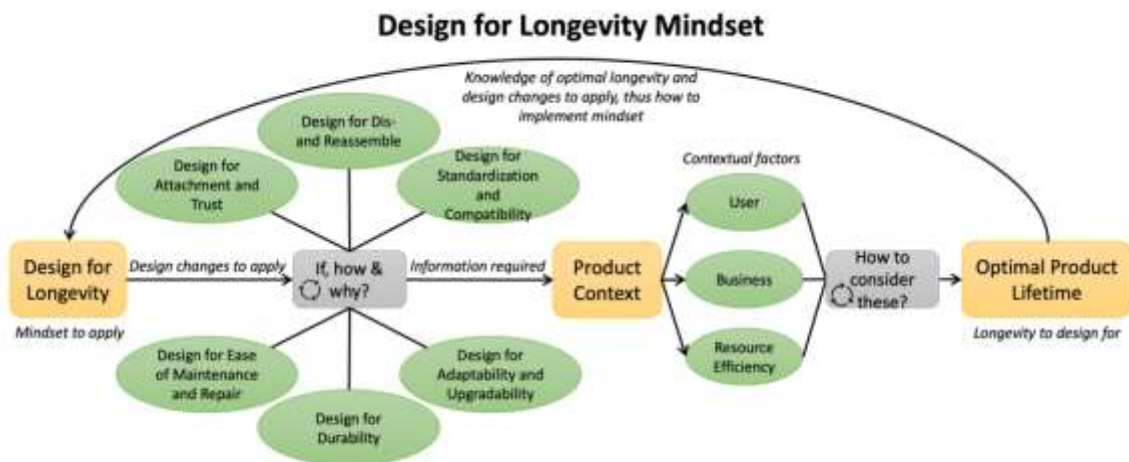
In short, these are the goals of the Right to Repair movement:

1. **Make parts and tools available.** Individuals and repair shops should have access to the parts and tools—including diagnostic tools—necessary to repair their products.
 2. **Make repair information available.** Repairs can be complex, especially with modern equipment in the tech industry. Knowing how to perform repairs is equally essential. Individuals and repair shops should have access to manuals, schematics, how-tos, and software to bring down limitations on repair.
 3. **Allow unlocking and customization.** An owner should be able to adapt and modify their products and install custom software.
 4. **Design “repair-friendly” products.** Manufacturers of products should design their devices and equipment so they can be easily repaired and modified.
- [Apple introduced Self-Service Repair in November 2021](#), which let users access more than 200 genuine parts in more than 7,000 locations in the US, expanding to other countries in the future.
 - [Google will offer Pixel users more options to repair their phones](#). Skilled users can make their own repairs or get help from third-party services in the US, Canada, and the European Union. Germany, Japan, and the UK are next in line.
 - [Samsung announced its self-repair program](#) starting with Galaxy S20 and S21 phones along with Galaxy S7+ tablets.

Lifespan



Graph of desired service life vs. actual service life (Almefelt, 2020)

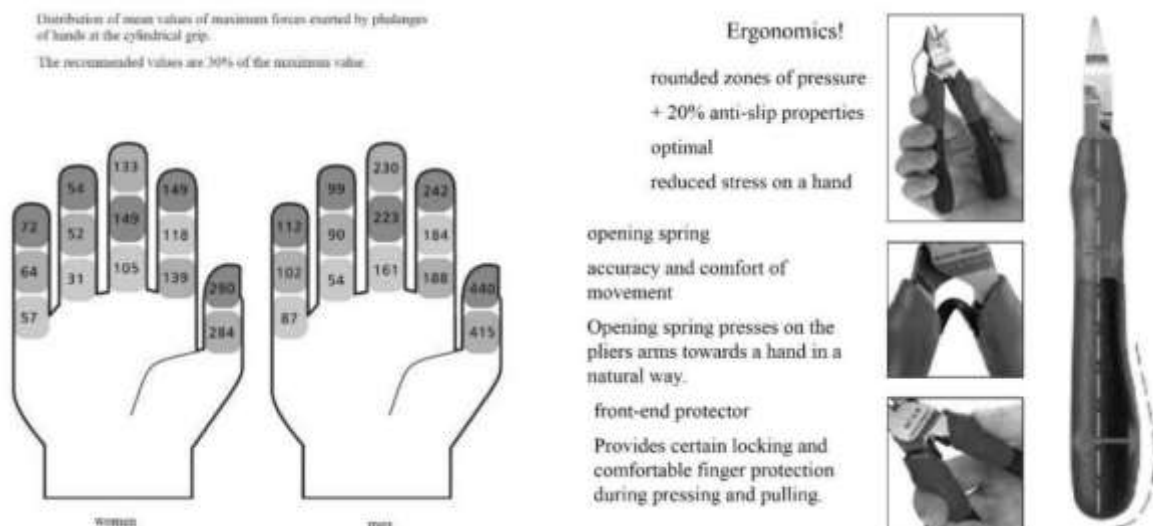


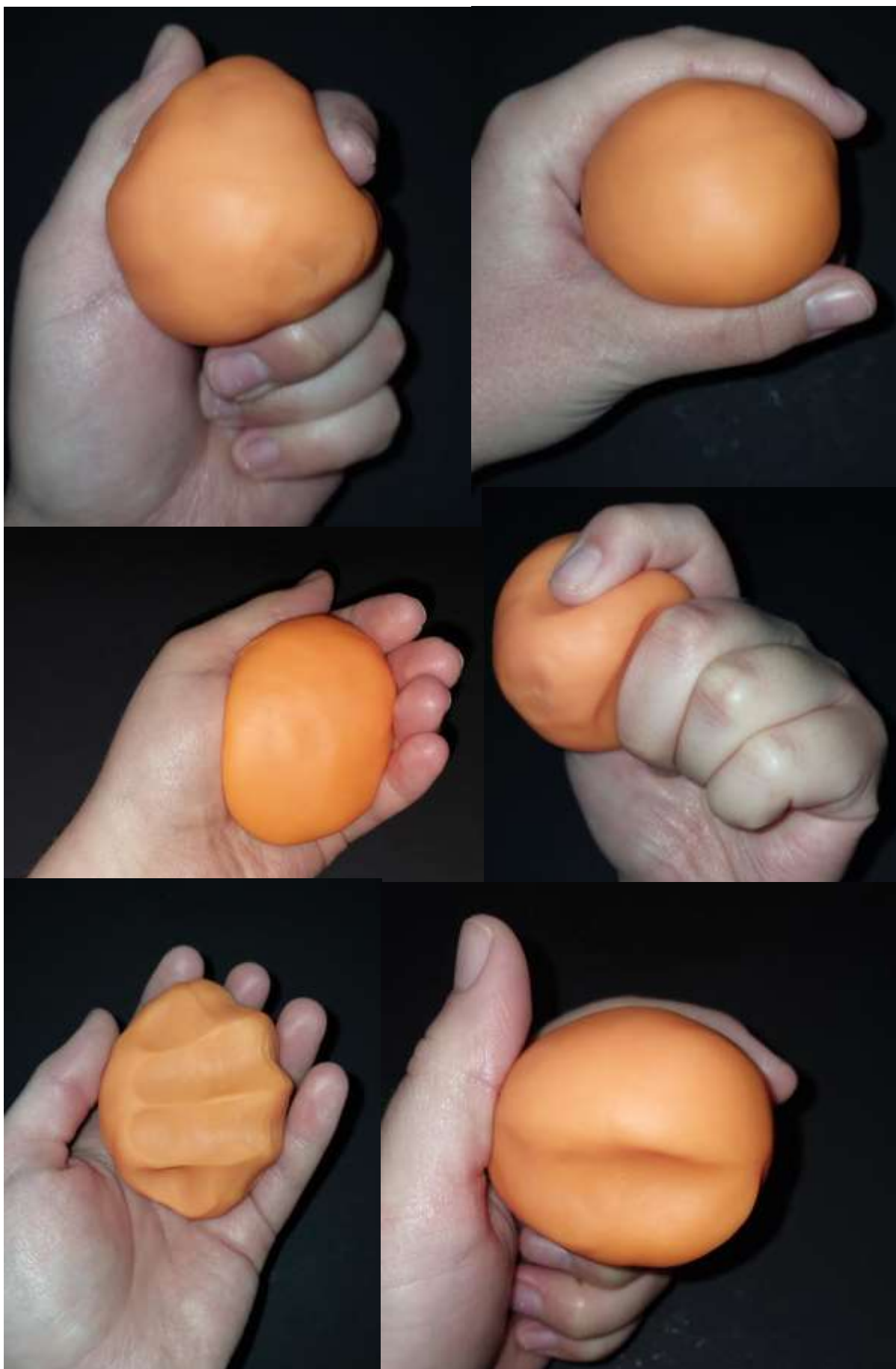
Flowchart for design for longevity mindset (Carlsson, Simon, Mallalieu, et al., 2021)

Ways to extend lifespan

- Design for repairability
Easy access to components, make components available, create physical areas within design (sensor, outer casing and screen areas) (don't damage other areas when repairing), design for standard tooling, have repair information available.
- Use durable material
- Design for the change of casing
- Send digital updates
- Design for product experiencing forces, sat on/dropped
-

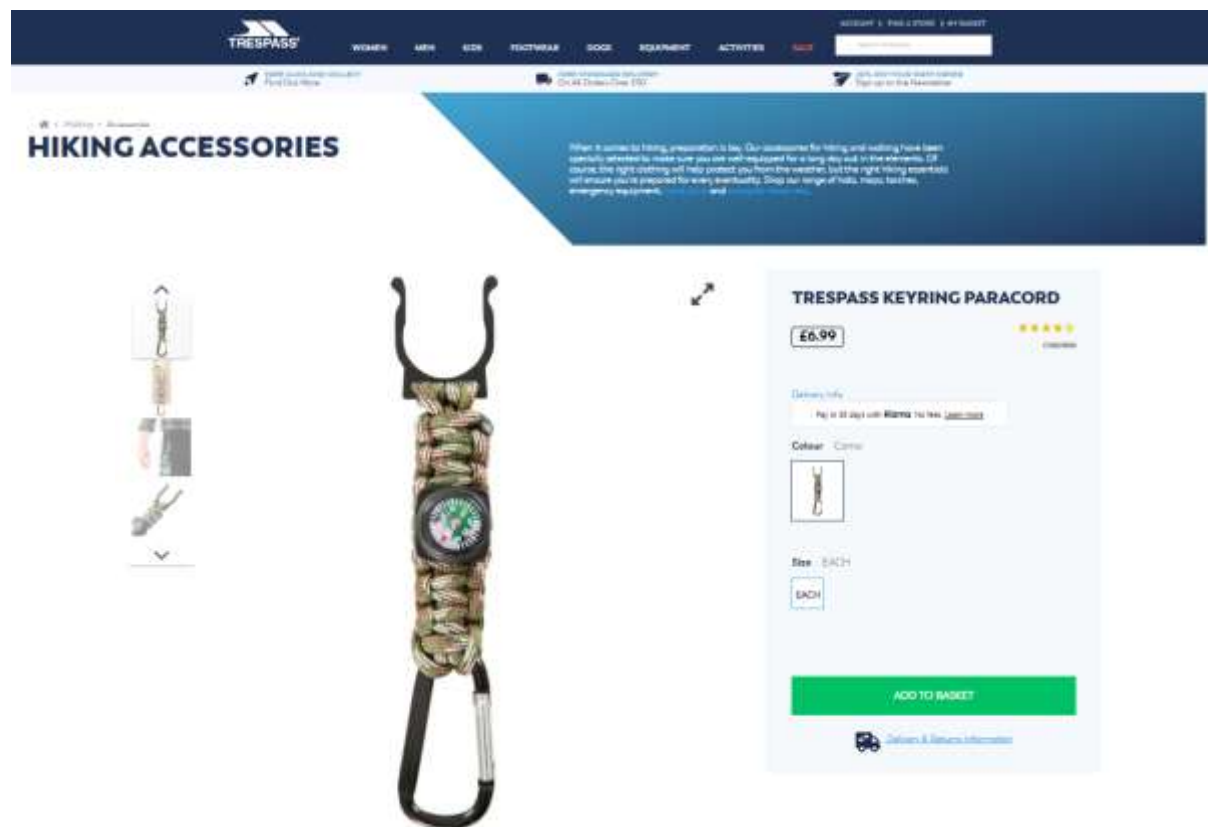
Ergonomic shapes





Concept generation and initial prototype iteration

Product environment



Garmin
Instinct® 2 Solar Multi-Sport GPS
Smartwatch
[Members Price](#)
£279.00
Retail Price £390.00



Garmin
Instinct® Solar Multi-Sport GPS Watch
[Members Price](#)
£249.97
Retail Price £400.00



Garmin
inReach Mini 2
[Members Price](#)
£299.00
Retail Price £350.00



Folding Bowl With Karabiner - 350ml

[Jackson Pet Co](#)

~~£6.99~~ Save 43%

Now £3.99

Free Delivery

Sold & shipped by Mountain Warehouse

Choose a Size - One Size

ONE

Low stock - We only have a few left!

[View Size Guide](#)

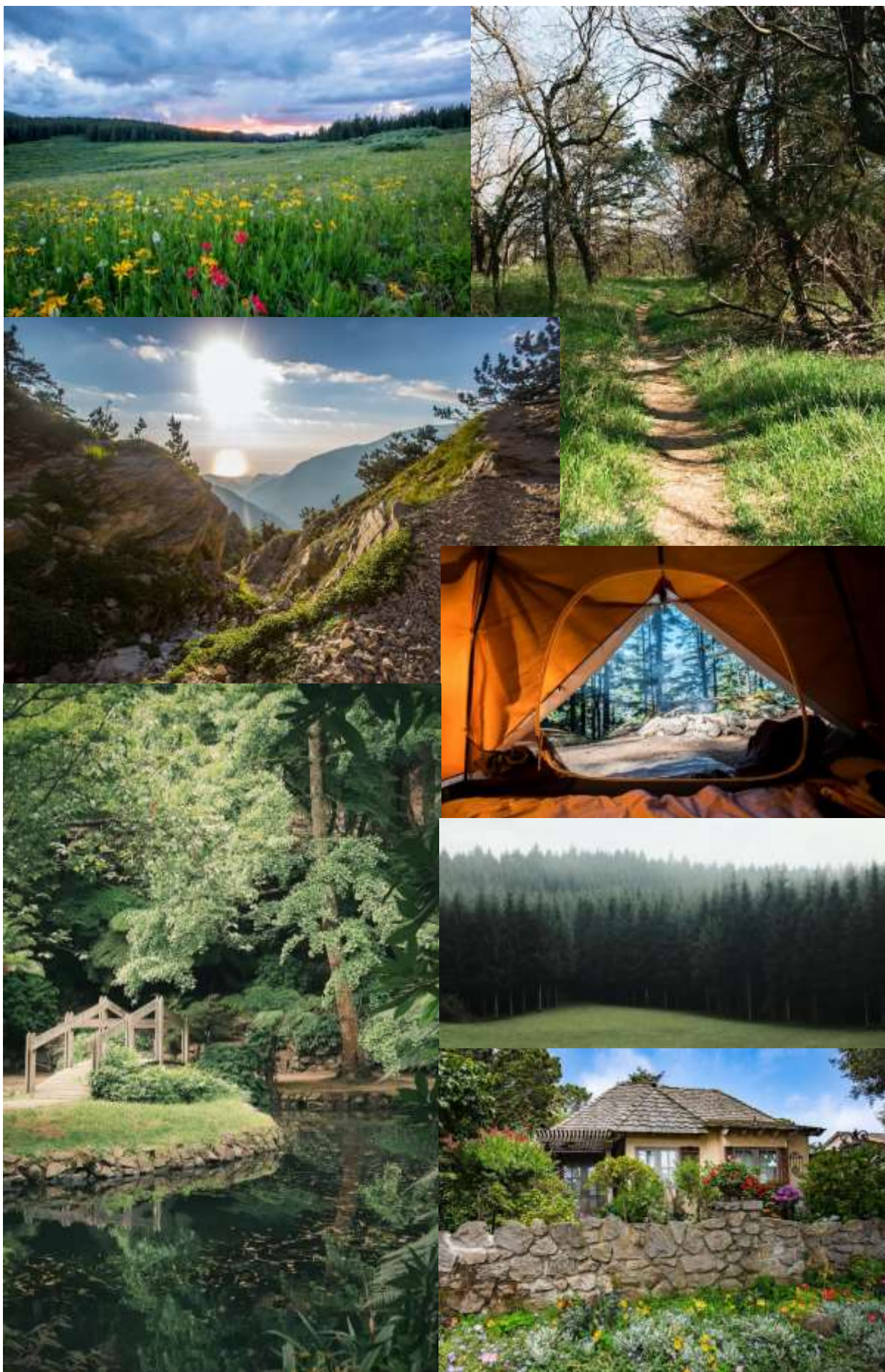
Quantity

1

[Shop now](#) Pay it in 4, Always interest-free. [Details](#)

Add To Basket





Common background colours



Common shop colours



What to take forward:

Avoid background colours, consider common item colours

Has to stand out next to other items

Need to be easy to clean

Looks compatible with other items in store

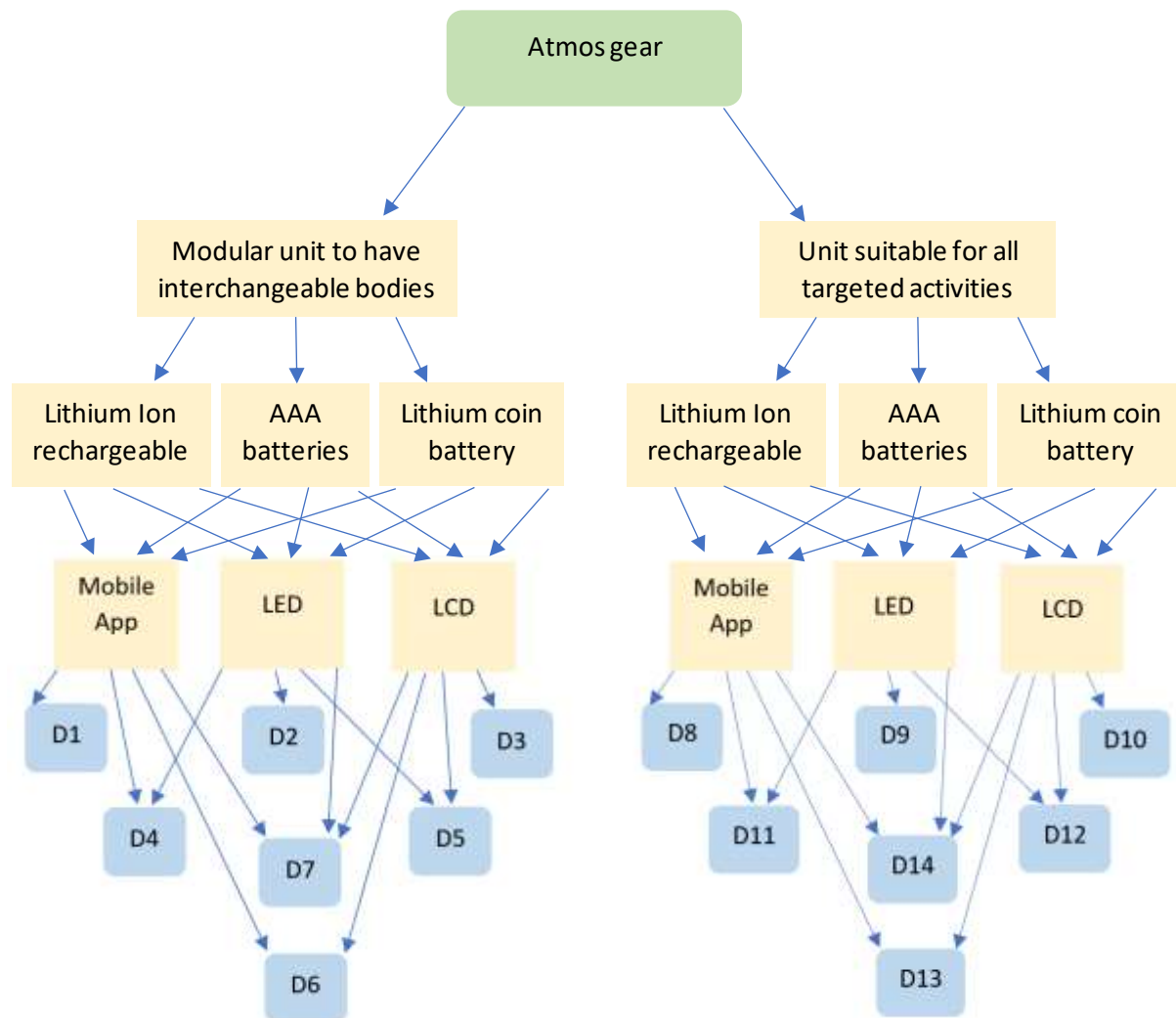
Looks indicate function

Screen has infographics on sale photos

Inspirational Brands



Design directions



Each drawing sheet to include designs with humidity, temperature, pressure and altitude.

Ideation boards

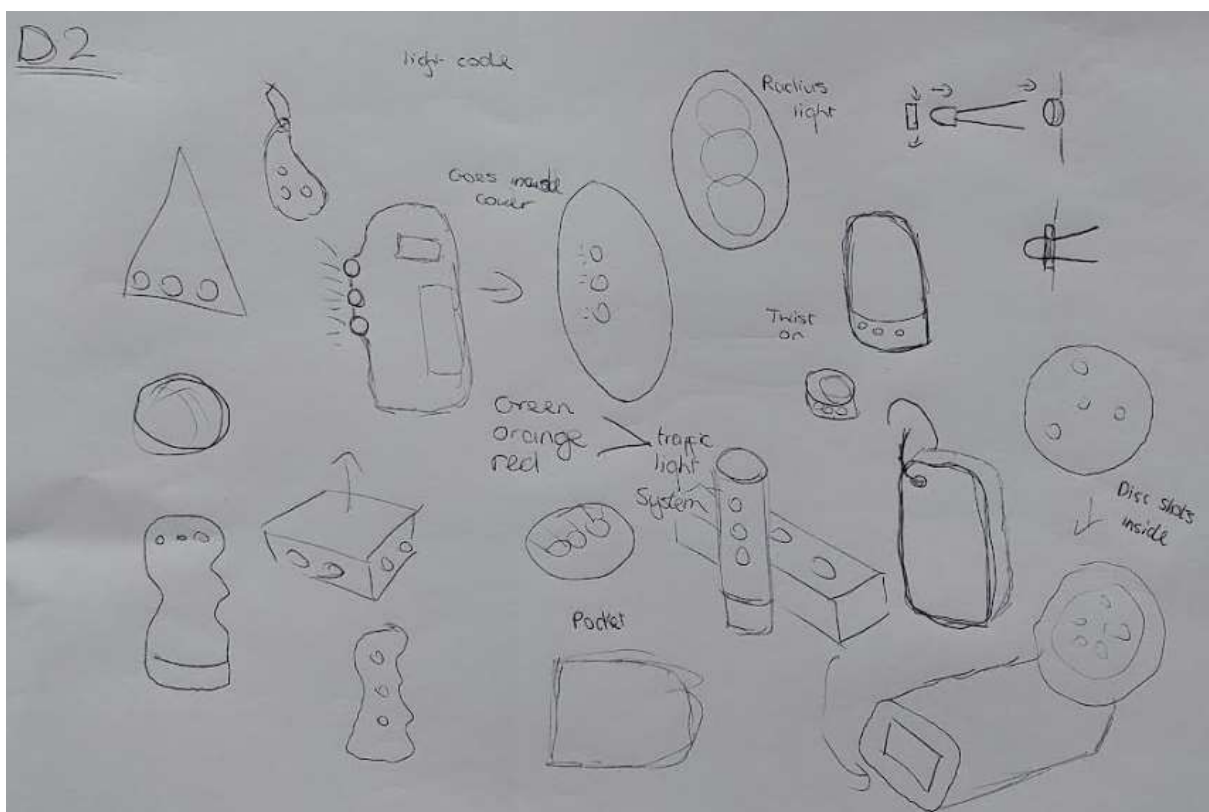
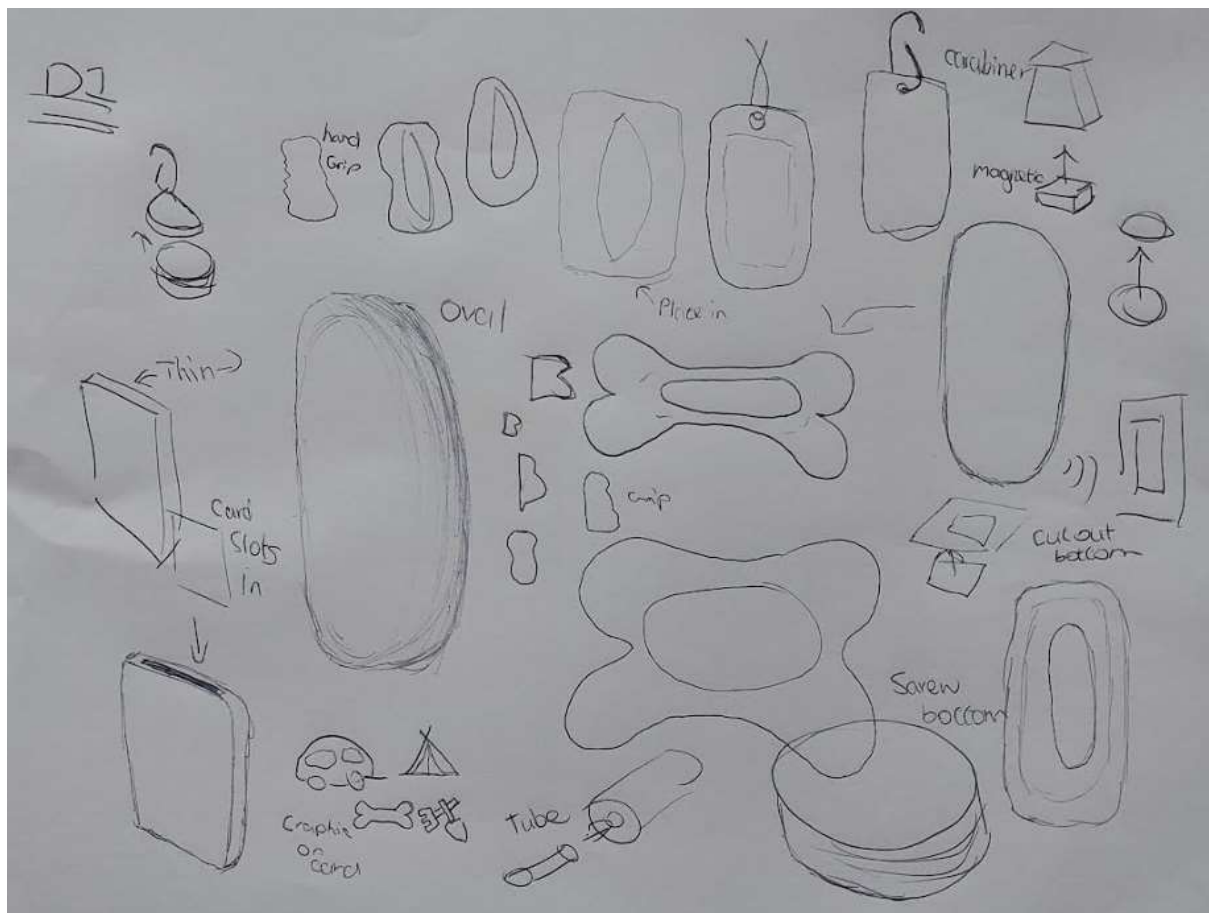
APP



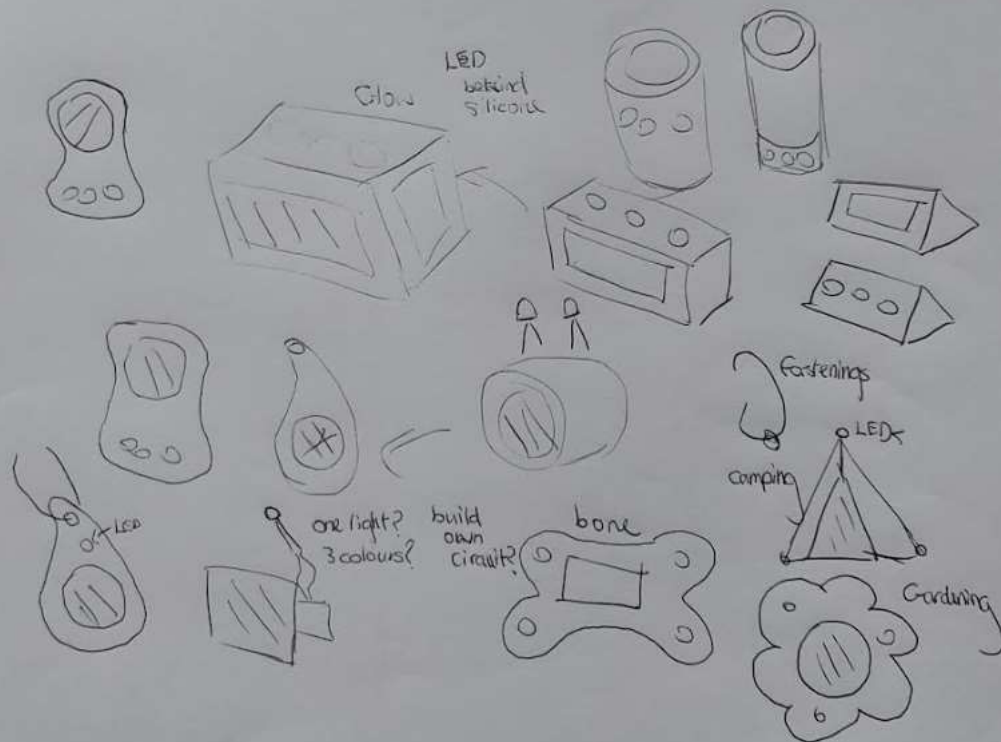
Product



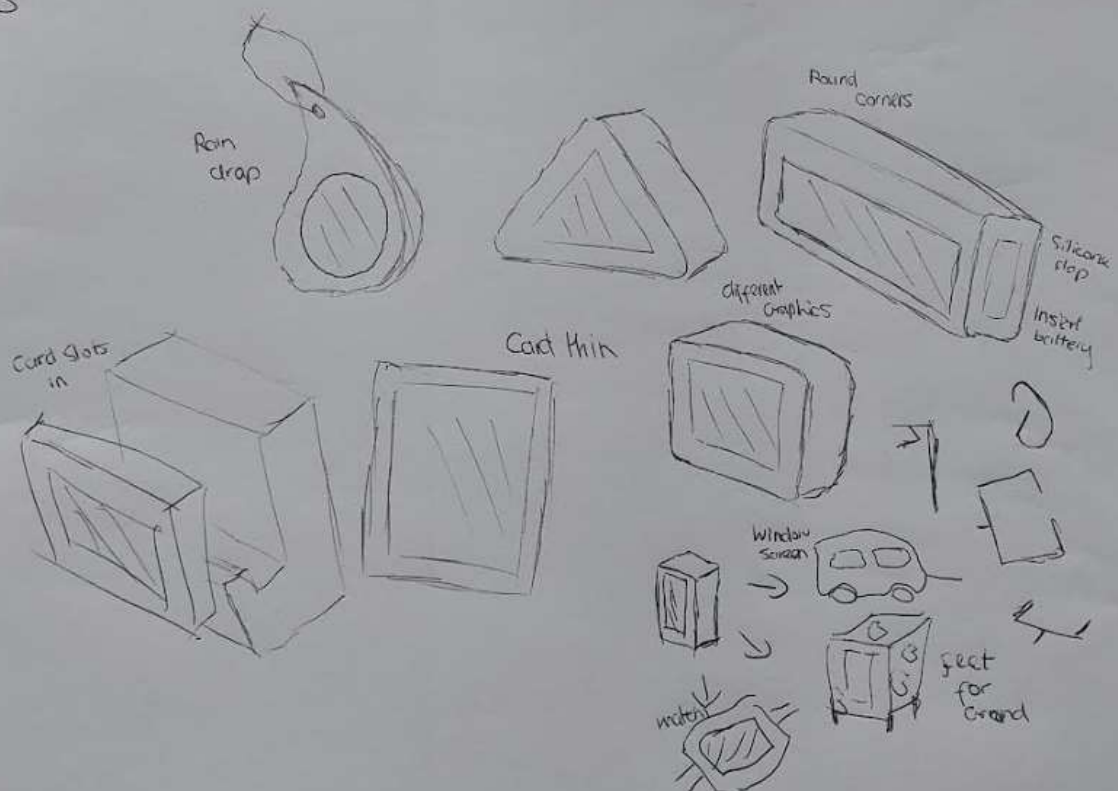
Design exploration



D4

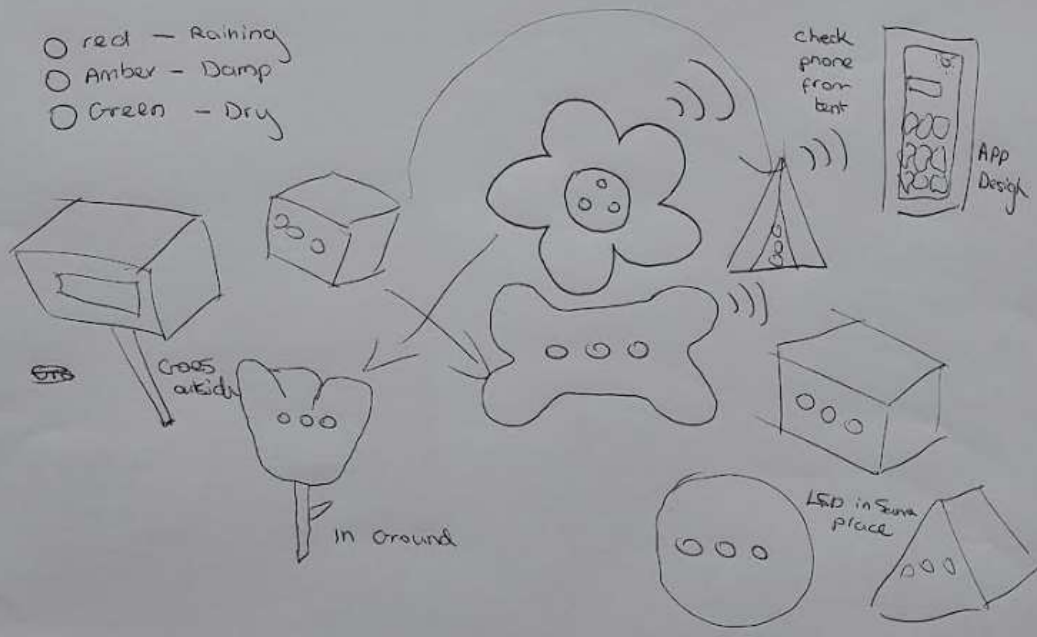


D3

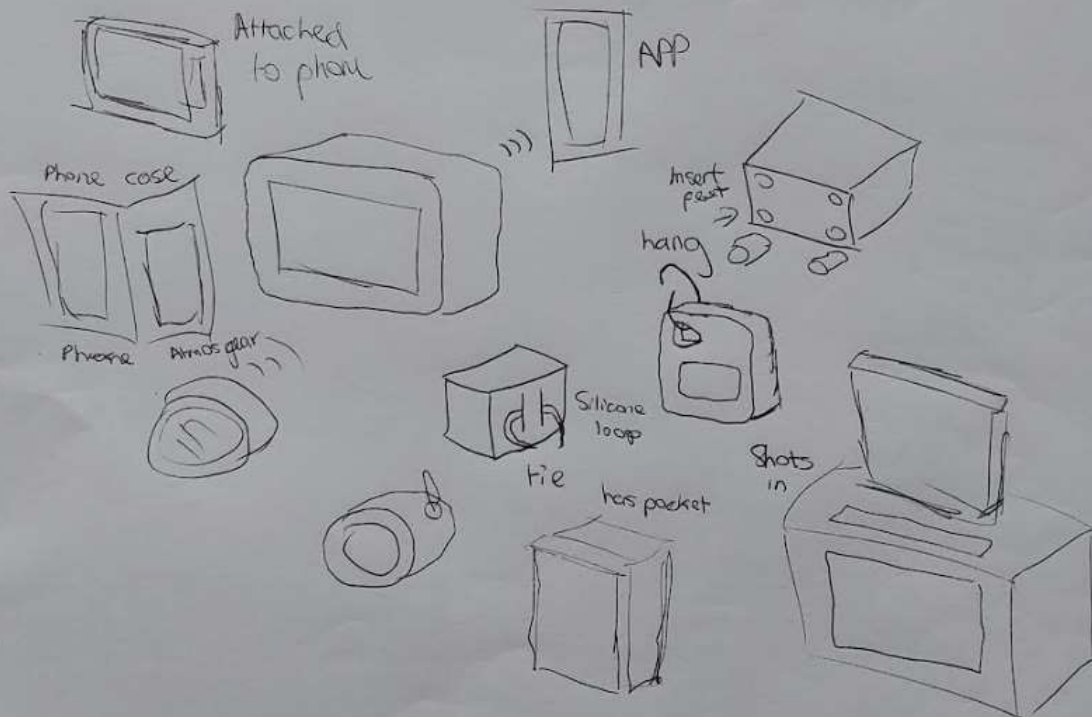


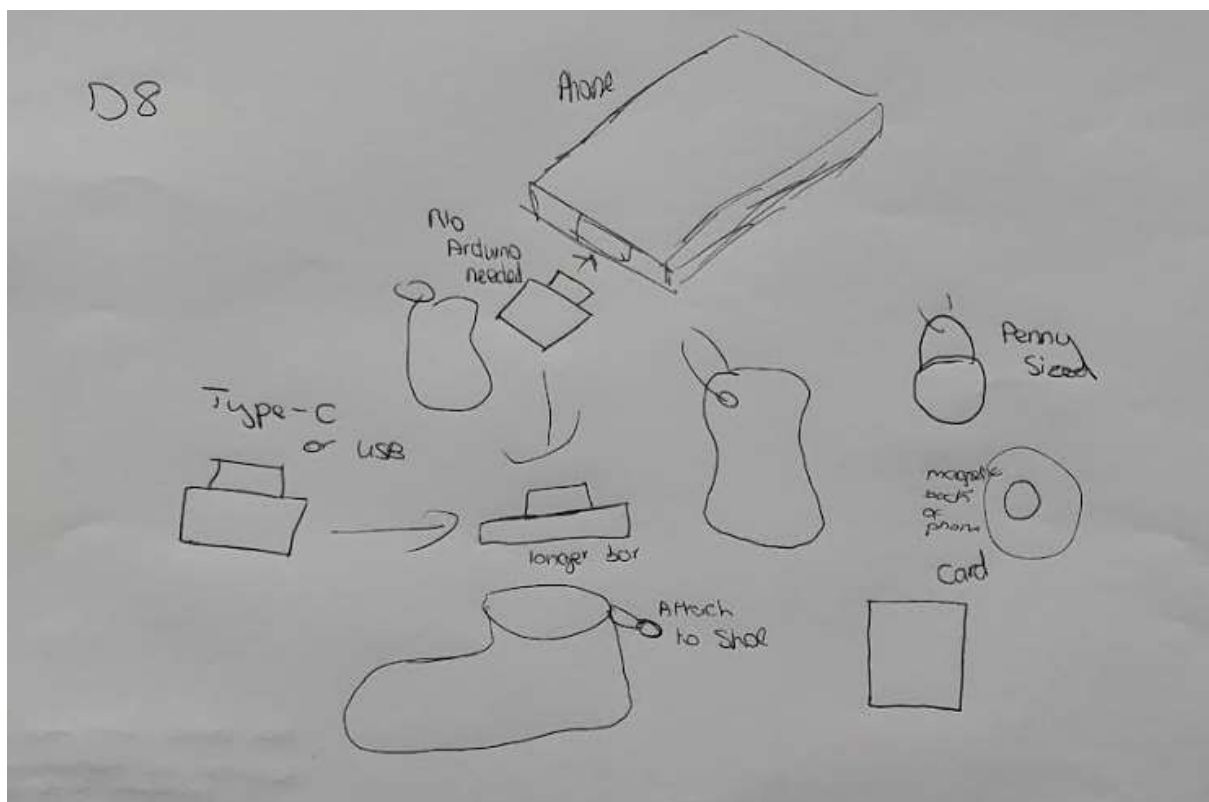
DS

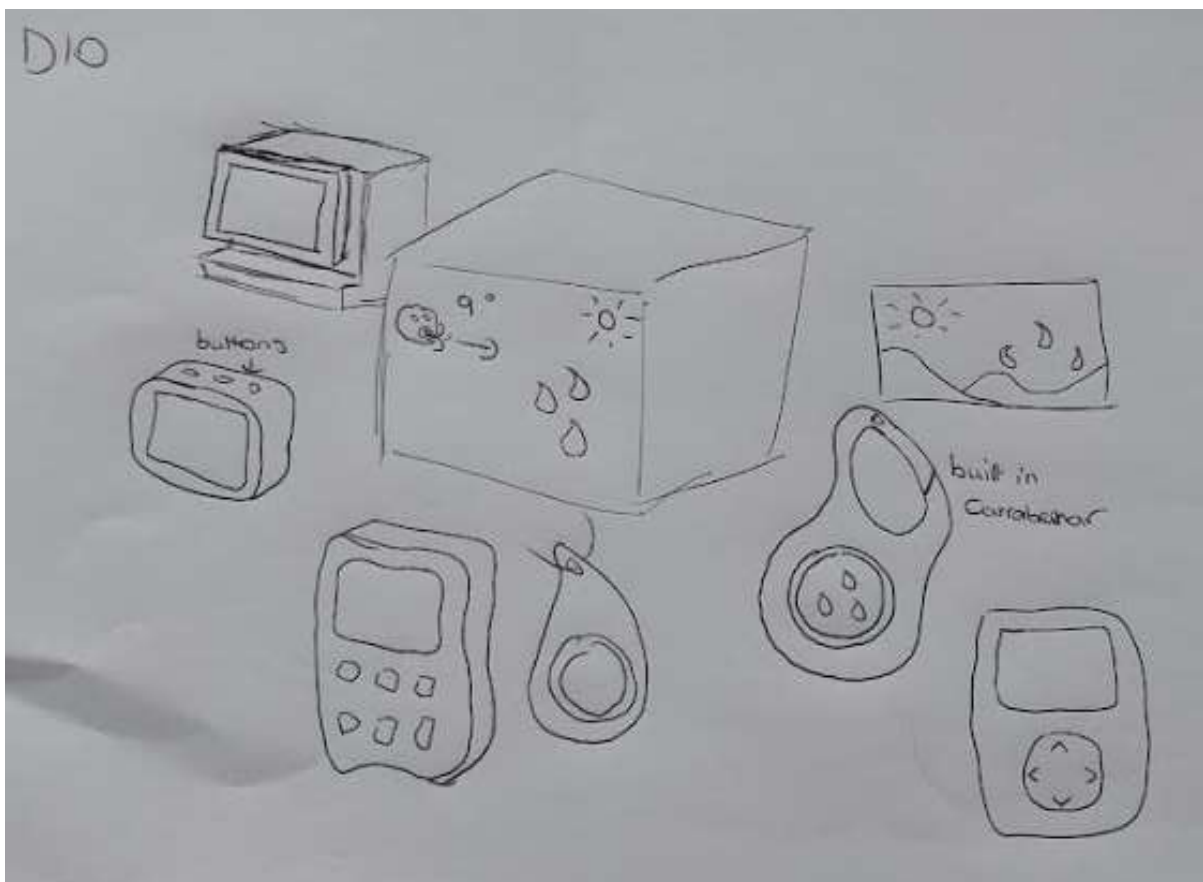
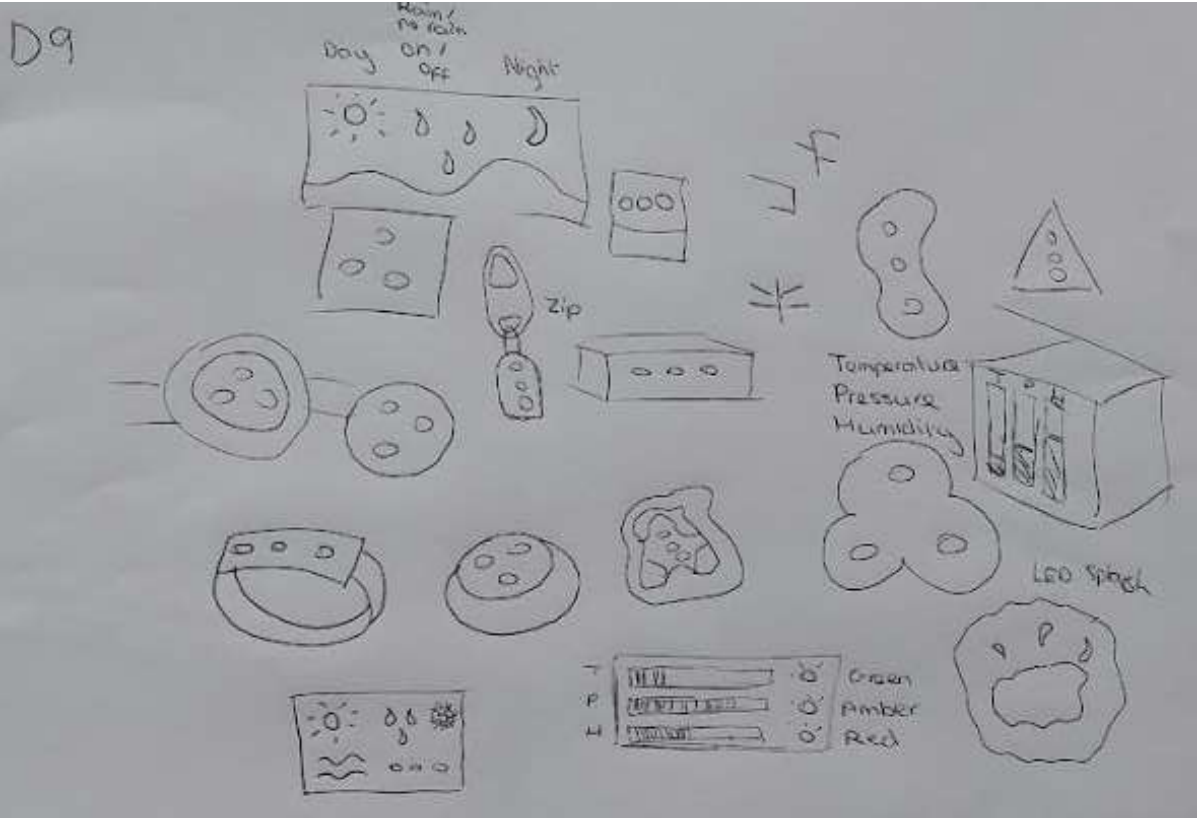
- red - Raining
- Amber - Damp
- Green - Dry



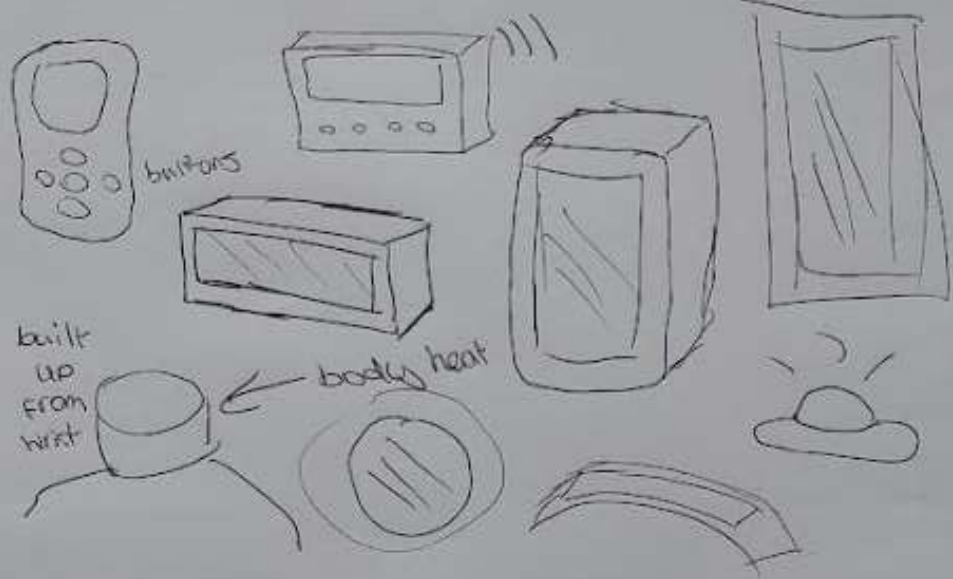
DS







D13



D14



Design Directions

Direction 1

Device to hang on bag with sound and light



Medium size device

Able to attach to bag strap, belt loop or carabiner

Would need sound or vibration to communicate with user and user won't be able to view it on backpack

May receive a lot of force from dropping bag, needs to be strong

To maintain fresh look needs to be scratch resistant



Direction 2

Small device with LCD screen to be attached to zip on pocket or coat



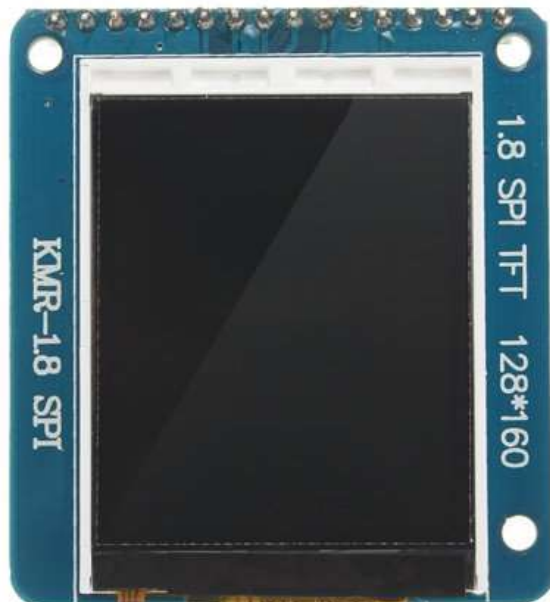
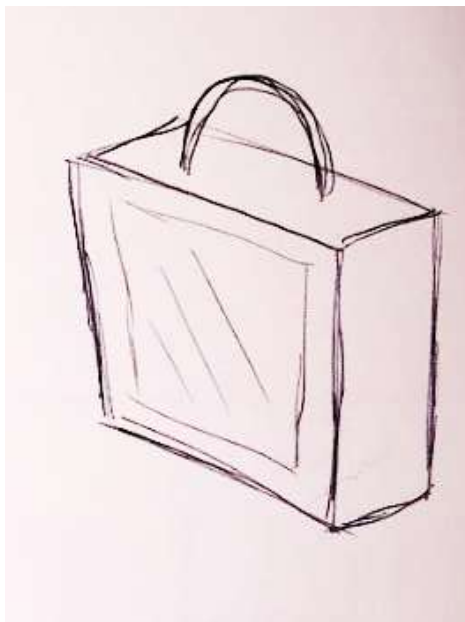
Small lightweight

Would need the smallest components available on the market = higher manufacturing cost

Easy access

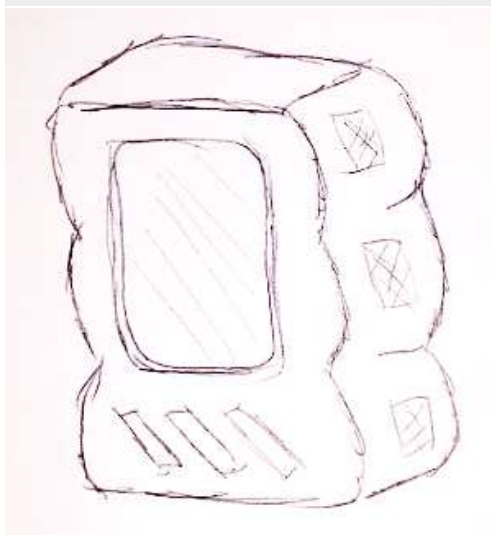
How to get best results without body heat interfering??

Friendly soft look



Direction 3

Large device for hand carry with LCD screen, LEDs and wireless connection



- Smooth black rubber surface
- Simple infographics on screen
- Durable look

Reference

Almefelt, L. (2020), "Design for Resource-Efficiency: From Principles to Synthesis of Resource - Efficiency Solutions", Chalmers University of Technology, Lecture material, Gothenburg, Sweden.

Carlsson, S. et al. (2021) 'DESIGN FOR LONGEVITY - A FRAMEWORK TO SUPPORT THE DESIGNING OF A PRODUCT'S OPTIMAL LIFETIME', in Proceedings of the Design Society, pp. 1003–1012. Available at: <https://doi.org/10.1017/pds.2021.100>.

Królikowski, J. and Polak-Sopinska, A. (2018) Ergonomics For People With Disabilities : Design For Accessibility. Edited by J. Królikowski and A. Polak-Sopinska. Warsaw ;: Sciendo,. Available at: <https://doi.org/10.2478/9783110617832>

Keating, G (2014) Tennis in rain. Available at <https://shawparktennis.com.au/rain-rain-go-away-make-up-day>

Useful links

[Arduino Nano 33 BLE Sense Rev2 with headers — Arduino Official Store](#)

[Arduino Nano 33 BLE with headers — Arduino Official Store](#)

[What Is the Right To Repair Movement? All You Need To Know \(refurb.me\)](#)

[Best weather apps for 2023 | Tom's Guide \(tomsguide.com\)](#)