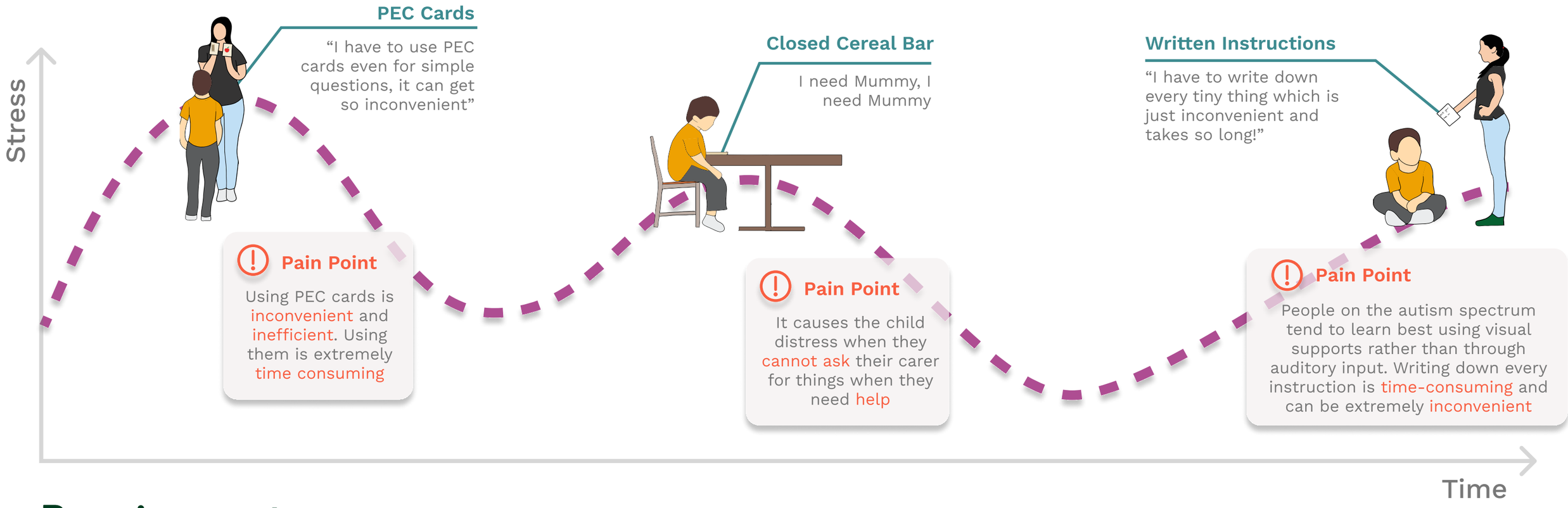
Yoto were not engaged in any consultancy or collaborative capacity with this project and the outcome is in no way endorsed by them. Any publicity is limited to personal and academic use'.

Product Opportunity

Our target user group is severely autistic, non-verbal children aged 4 to 8. A user journey map was developed to understand their day-to-day difficulties and find design opportunities.

User Journey



Requirements

Durable | Easy to clean | Hides electronics | Lightweight | Affordable | Waterproof

Value Proposition Canvas

To ensure that the products accurately fits into the market, a value proposition canvas was created. This will help achieve a product-market fit.

Products & Services

PEC cards help kids communicate by using images and visual cues

QT Bot is an emotionally expressive robot that teaches autistic children about social interaction

Proloquo2go is a paid app available on iPads which allows autistic children to communicate using images

Gain Creators

Products should aid communication between autistic children and adults

Products should help children to learn while not requiring them to constantly be looking at a screen

Products should prioritise improving the user's physical and mental wellbeing

Children cannot communicate if they are hungry or thirsty to their carers

Children cannot communicate their emotions to their carers

Children struggle to listen to and follow through on instructions as they get distracted

Pain Relievers

Gains

Being able to communicate their desires and emotions to their parents would help reduce the frustrations of the carers and child

Learning how to communicate effectively enables the child to live more independently

Following instructions easily makes life much more efficient and hassle-free

Jobs

Users should be able to follow instructions easily

adults should be able to effectively communicate instructions to the child

User should be able to communicate their desires (e.g hunger, toilet etc.)

Pains

Inability for child to communicate desires/ emotions or the carers misunderstanding what they want causes frustrations

Since child cannot communicate, adult constantly has to be around them, and continually guessing what they want

Following instructions is not easy for child, and therefore carers has to keep repeating themselves

Value Map Analysis

The most effective device would help children **communicate** their desires to their carers, whilst also allowing the parents to relay **instructions** to their child. We found that **imagery** is the most effective way of helping children to learn, whilst also ensuring good mental and physical health. The users should not become overwhelmed using the device.

Customer Profile Summary

Analysis of the user profile (children) and the buyer profile (carers), showed **functionality** is the most important aspect of the device. Buyers also want a **low-cost** product (currently many solutions are expensive). **Aesthetics** are least important, however they must be considered to prevent the device causing visual distress to the child.

Concept Selection

The four ideas that were generated were ranked based on impact, desirability and feasibility in order to decide upon which would be taken forward for further development and manufacture

Olle

low impact — high impact

undesirable — desirable

unfeasible — feasible

Routinee

low impact — high impact

undesirable — desirable

unfeasible — feasible

Arama

low impact — high impact

undesirable — desirable

unfeasible — feasible

U Me

User feedback and the evaluation done by the team were combined, and it was decided that U Me would be the best to develop further. Modifications would have to be made to the design to ensure that it was feasible as well as achieving the user's needs.

low impact — high impact

undesirable — desirable

unfeasible — feasible

Branding

Several brands were analysed to see which our product would fit best into. They were first evaluated using a matrix before three were analysed in depth.

The nature of the product means that it can fit into a wide variety of brands. These brands were analysed based on how inclusive they are, and the style of their products.

Out of all the brands that were analysed, we decided on three to considered further. They are **Mothercare**, **National Autistic Society** and **Yoto**. Mothercare is a large company with a broad range of products, NAS' clientele match our user group and Yoto have a smaller range of products with a clear design language.

Brand	Mission Statement	Will our product fit in
mothercare	Our mission is to meet the needs and aspirations of parents for their children, worldwide. We want to be the primary provider for mothers and children up to the age of eight.	Mothercare stocks a large variety of own brand products from clothing to toys. Therefore, manufacturing will be possible without needing to expand infrastructure. They are also looking to be a provider for families of all abilities, meaning that a device for autistic children fits into their vision [2]
National Autistic Society	Our mission is to change the lives and attitudes of people affected by autism and the general public	NAS do make products, however this on a fairly small scale as it is not the main aim of the charity. An attempt to have them manufacture and sell U Me would need a great deal of investment before it could be viable [3]
yoto	Our mission is to provide a screen-free way of learning to all children	Yoto stock many products which inspire children to learn with audio without using screens. They have a clear design language that fits U Me [1]

After analysing these three brands, it was decided that Mothercare and Yoto should be investigated in greater depth. While the National Autistic Society do stock products, it is on a very small scale, and these tend to be very simple products, such as PEC cards. Therefore, to see which brand would fit the best, an in depth brand analysis of both **Mothercare** and **Yoto** will be carried out.

Brand Comparison

Our in-depth analysis revealed 2 possible brands into which our product could fit, Mothercare and Yoto. We will now analyse these brands to find the one which would be best.

Our Values

- ensure that our users are treated with **respect**
- prioritise the **mental and physical wellbeing** of our users
- design all our products to be **fair** to our users

Mothercare Values

- design all products to be **safe** to use
- **innovation** should drive our products
- our products should be **relevant** for parents and children

Yoto Values

- get children away from **screens**
- encourage children to **learn**
- help children to be more **independent**

Mothercare vs Yoto

Mothercare Products


educational toys


battery powered


sensory toys

Mothercare have several ranges that the product can fit into, or it could be the start of a new product range, with products designed for children with disabilities.

Yoto Products

Yoto have 2 products, the Yoto Player and the Yoto Mini. Our product could be a third one to add to their range.

Brand Comparison

	Pros	Cons
Mothercare	✓ have existing infrastructure to manufacture on a large scale ✓ presence in many countries	✗ so many products may cause our product to get lost in their range ✗ our values and the brand values are not too closely aligned
Yoto	✓ obvious design language & clear branding ✓ clear alignment of values ✓ U me will be an obvious addition to the range and will stand out more	✗ less international presence ✗ less existing manufacturing infrastructure

Final decision

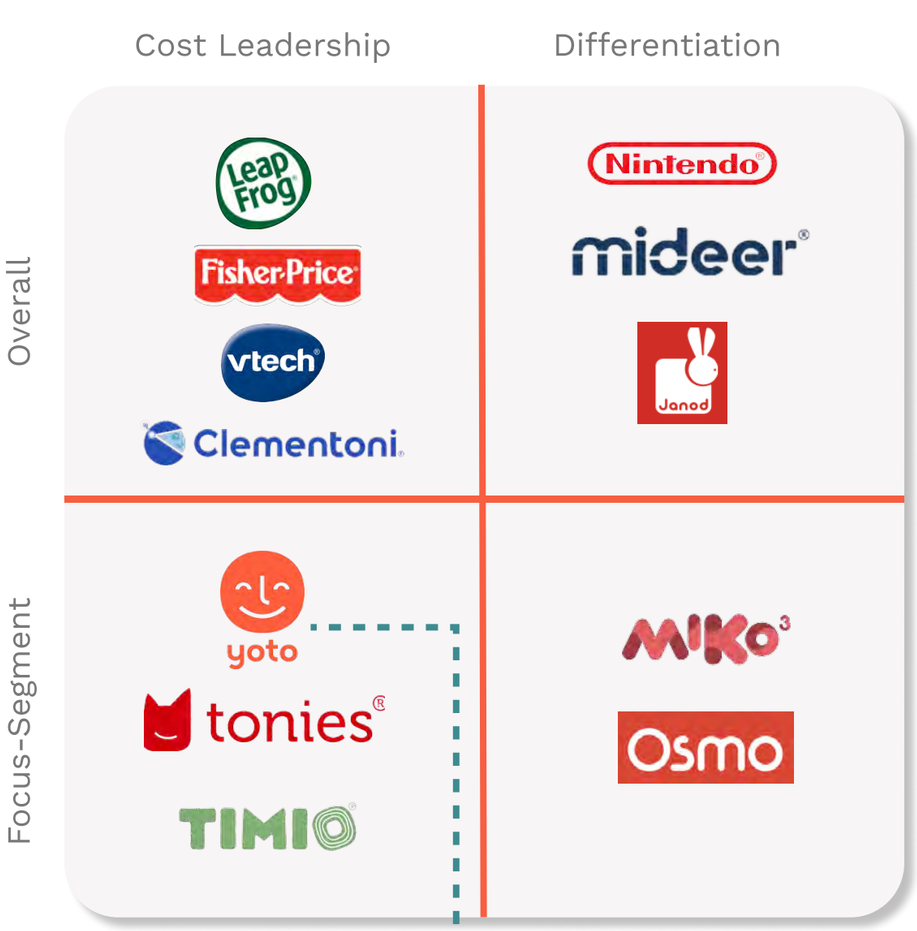
yoto

After analysing both brands, we decided that **Yoto** would be a better fit for our product as their values align better with ours. U Me would have a more significant presence and expand their market into visual communication, as opposed to audio. This will appeal to children who don't benefit from audio.

Yoto: Market Analysis

We carried out research to understand where Yoto fit within the market and how our product might differentiate them from their competitors.

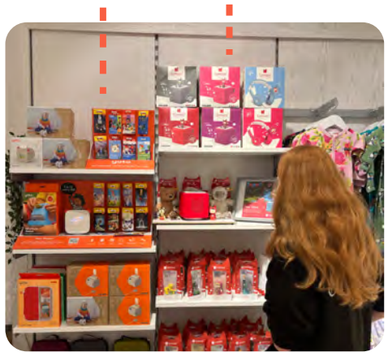
Porter's Generic Strategies



Insights

Yoto's strategy is to provide a **low-cost** product, but to a **narrow** target market. This is a similar strategy to their biggest competitors, Tonies and Timio.

Yoto Tonies



Analysis of Yoto's Closest Competitors

To understand how our product could add to Yoto's product portfolio, we analysed the products of Yoto's biggest competitors from each category.

	Relative market cap ($)	Product most interesting for our users
yoto		 Play through audio stories by putting different physical cards into the player
vtech		 KidiCom combines education, play and communication. Carers know that their children are safe on the internet.
Nintendo		 Switch moves away from traditional online gaming and encourages in-person collaborative play through the two removable controllers.
tonies		 Tonies prioritise the safety of their products, as they don't have screens, cameras or microphones. It also allows the children to interact with their favourite characters.
MIKO 3		 Miko is a study buddy. Miko's interactive and engaging nature allows the children to learn a huge range of academic topics, whilst being personable.

Business value proposition

Similarities between Yoto and competitors

- No screen approach (like Tonies and Miko)
- Safe for kids (no cameras or microphones, safe internet access)

Differences between Yoto and competitors

- No communication aspect to product (like in most other products)
- No character aspect to product (like Tonies and Miko)

Therefore our product will help add a **communication** factor and **character aspect** to their product portfolio. It will also enable a **wider audience** to access their products and become more appealing to carers of children with ASD.

Technical Review - CMF

We carried out in-depth, technical analysis of the Yoto products, so that we can replicate the CMF on our design.

Colour Review

The Yoto player only has one colour way (white with red/ orange buttons). Therefore to customise it, 'jackets' can be bought. The jacket is available in seven different colours. This allows children to **personalise** their player or **differentiate** it between sibling's players.

"Schools are always full of bright colours so having a bright colour scheme shouldn't be a problem for the children. Having stickers or images on the product would also make it more customisable which children would love."

Material Review

Jacket Material

The jacket is made from **silicone** It is hygienic so is safe for children to use. It is also non-toxic, water-repellent and recyclable.

Card Material

Yoto cards are made out of **ABS** and **PETG**. ABS is used for the printed layer, as it has excellent stiffness and strength. The PETG is used for the protective cover as it offers excellent **protection.**

Casing material

We suspect the casing is made from **ABS** or **HDPE** due to it being durable and flexible.

Screen

A very small liquid-crystal display **(LCD)** is sandwiched between 2 pieces of **glass** and displays a pixelated image.

Finish Review

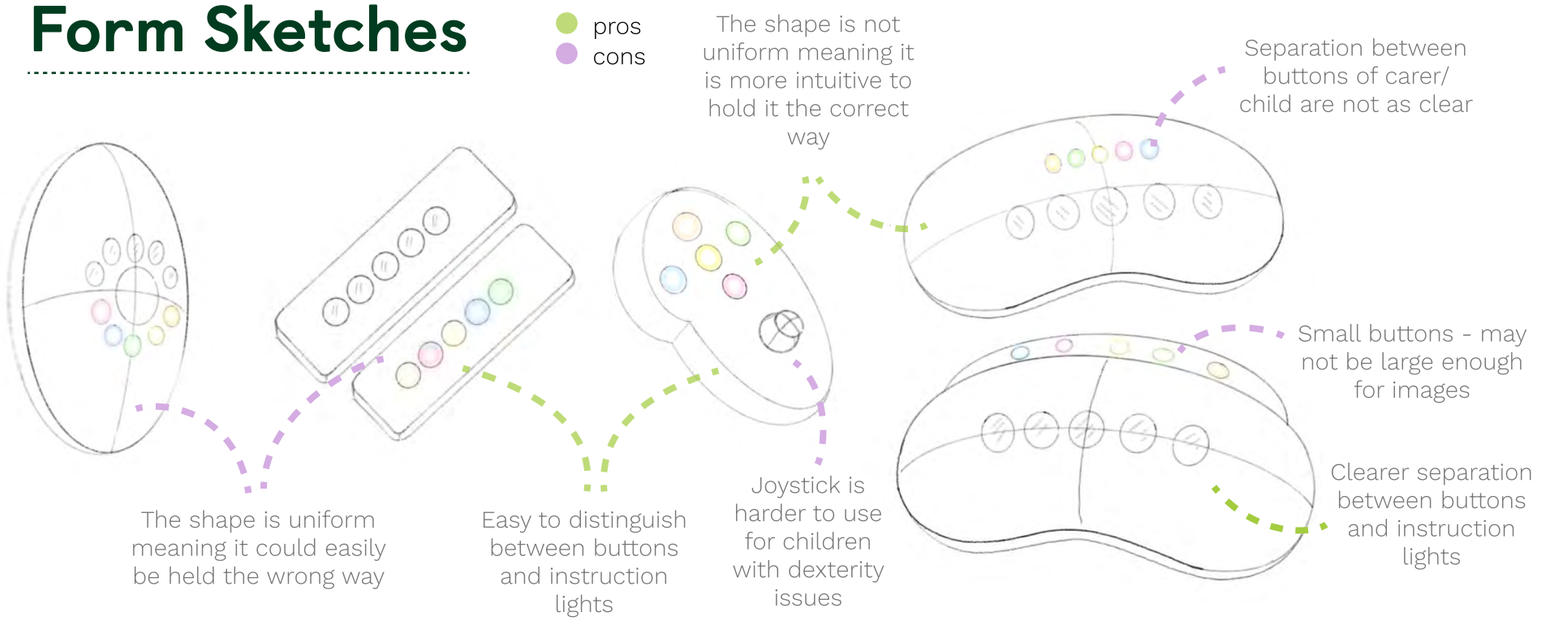
In both Yoto players the screens are flush with the casing surface. The surface has a grade C **matte** finish. This helps the images stand out. It also means that fingerprints or scratches are less obvious compared to glossy finishes. This is important for a kids device that will likely be dropped.

Concept Development – Form

We have explored multiple options for the shape of the U Me, so that it is comfortable to hold and use.

Form Sketches

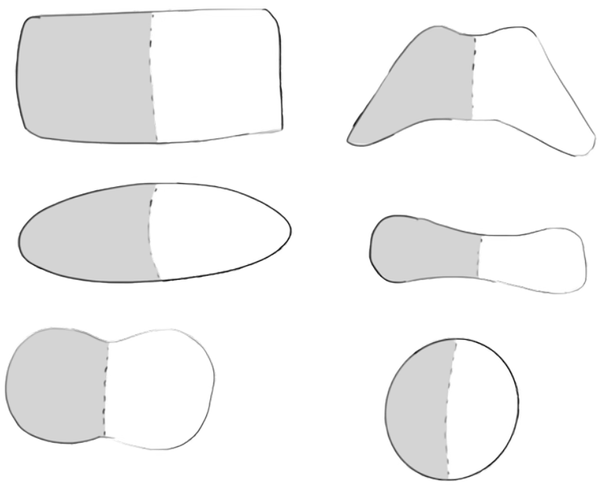
pros
cons

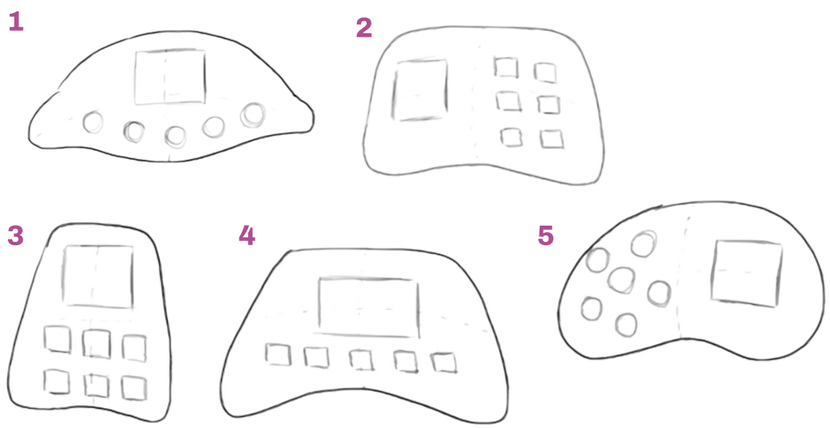


"The kids could easily communicate using only a few buttons but adults usually have more that they want to say to the child, so having only 5 things that they can communicate may not be enough"

Form Development

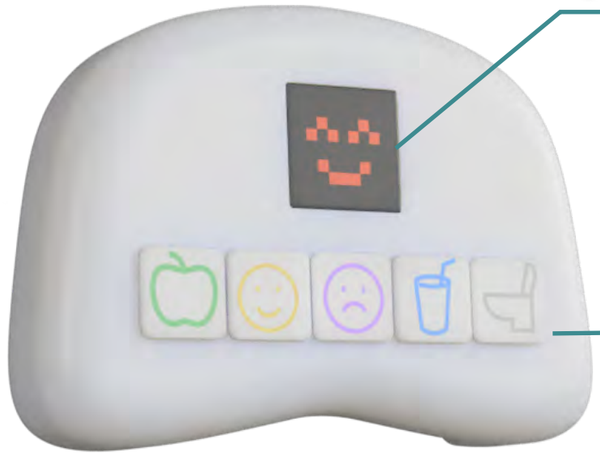
We experimented with several different **shapes** of the U Me in order to see which will be the best for the user. The colours reflect which side the children will use and which side will be used to display the carer's instructions.





After talking to users, we realised that only having 5 or 6 buttons for the carer is not enough. There are far more things they want to say to the child so replaced the buttons with a matrix display screen. This can be controlled by an **app**, which will allow the carer to have more flexibility with what they send to the child. This also removes the need for the parent to have a device, which is more practical.

"Simplified pixel icons would work well. They are not as detailed as a phone screen, yet still more expressive than words"



Pixel screen

The pixel screen will allow the carer to send more instructions, while also keeping with Yoto's brand. A pixel display with a matte finish will remove the need for an LCD.

Buttons

Buttons displaying images of essential things that a child may want to communicate

Button Design

Button Icons

"They aren't as social as neurotypical children so there isn't that many things they want say. 5 to 6 buttons would be enough for them "

Least Important — **Most Important**

Emotions

Since the kids cannot understand their emotions, they will be unable to communicate them anyway

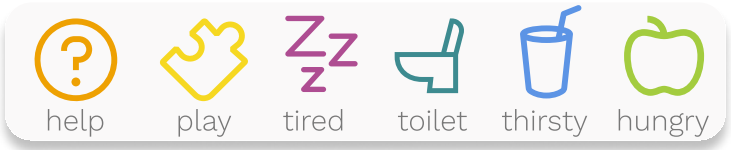
Yes/no

They have already learnt how to say yes/no even if they can't speak

Useful

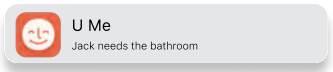
These buttons are essential, and they are things the parent cannot gauge automatically, would be useful as options on the U Me

Simplified icons:



Child presses button

Notification appears on phone

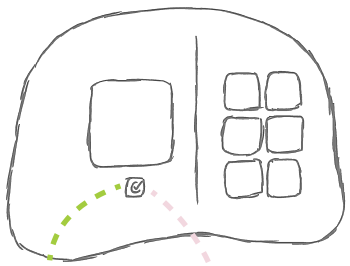


The "Done" Button

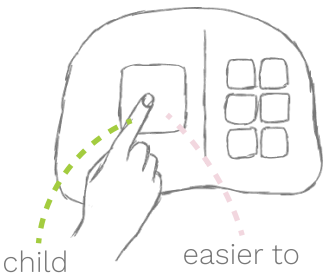
Once a task has been completed, it must be possible for the task to be marked as done, so that it will no longer appear on the screen of the U Me. We have explored multiple ways this could be achieved.

"I think it may be good to have a 'done' button or something that flashes up every minute or 2 until the task has been done"

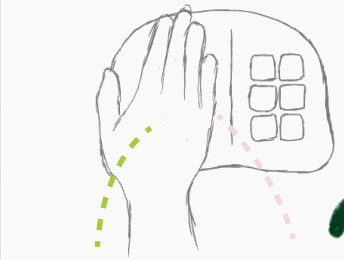
1 Done button below screen



2 Press screen



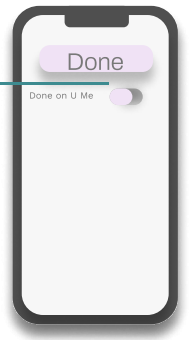
3 Cover screen

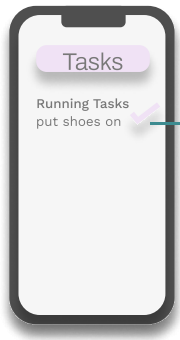


Covering the screen is what will be most familiar to the children, as it is similar to the way of saying "Done" in **"Makaton" sign language**. However, there is still the problem that it may be overused. This has to be controlled by the parent, using the app. If they **disable the done function** of the U Me, then they can mark when the task has been completed.

Toggle

Parent can toggle whether the done function on the U Me is on or off





Tick

Parents can click if task is finished

Separation of Sides

It is important for the child to differentiate between their side and the carer's side. To achieve this, we further developed the shape, as well as developing a jacket to cover the U Me.

Prototype Testing Feedback

Initial Design

" She has to move her hands to reach the middle buttons, she could not reach them that easily"

Mother of the 6-year-old who tested the prototype

Iteration

We altered the design so the buttons were easier for the child to reach.

"This design is better because the kids will be able to reach the buttons more easily, but different colours would help to differentiate the sides."

Mother of the 6-year-old who tested the prototype

Comparison With Existing Products

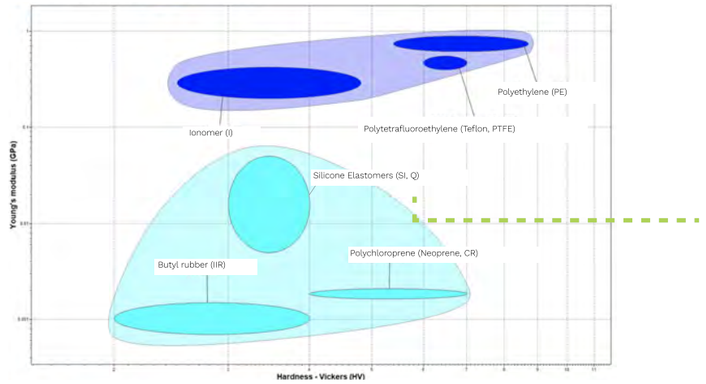
We compared our device with the Yoto player in order to validate that the **design languages** were **consistent** across both products.

Jacket Development

Why?

The jacket will be used to protect the U Me from inevitable bumps and falls. It will also help to differentiate the 2 sides of the U Me so that it is more intuitive for the child. Children with ASD are also sensitive to texture meaning the casing should be made of a comfortable material.

Material



We want to develop the product with a soft touch **silicone** jacket as it is durable, flexible and waterproof, whilst still being comfortable. This is consistent with Yoto's "Adventure Jacket". It is also non toxic which is a necessity for a child's product.

"Silicone is smooth and tactile so it's ideal for children with sensory issues"

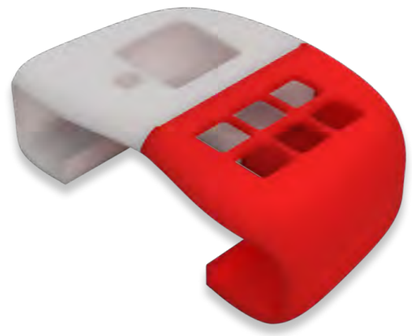
Final Design

Carer's side

Carers side is a simple colour that is consistent across all of the jackets

Child's side

Child's side has a variety of colours and patterns available which allows the child to personalise their U Me.



Electronics Integration

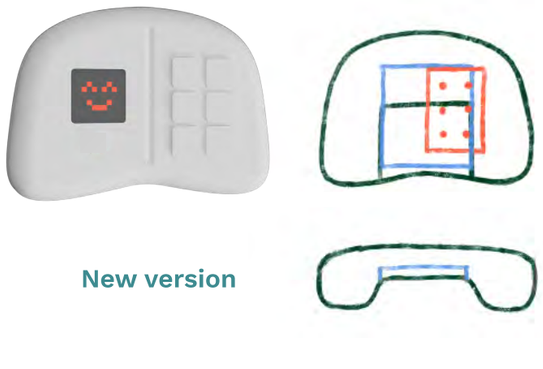
So that the adult is able to send more instructions to the child, it has been decided to replace the adult's device with an app. The electronics were prototyped to see exactly how they could work within the U Me.

PCB integration within the device

Since the device has a raised middle section, the PCB will sit on top so the button contacts can hit the PCB. By changing the button positions it meant that this was easier to achieve.

PCB = Buttons =

Old version



New version

From this, it was decided that the electronics should be assembled on the **base half** of the device rather than the top half so that the PCB can be directly screwed into the raised middle section of the device.

A limiting factor of the PCB design was the size of the device. We had to make a compromise between the size of the device so it could fit comfortably in the child's hand and fitting all the electronics in.

Size of first prototype

Size of final prototype

This final size was a good compromise between fitting all the components on the PCB and positive user feedback on ergonomics. However for the prototype we have increased the size by 10% and made it thicker to accommodate for all the wired connections inside - in the manufactured device the wired connections will be minimal.

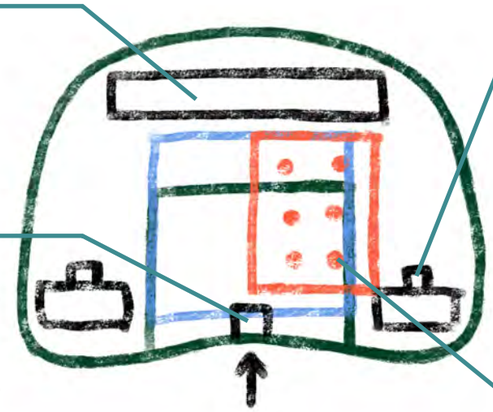
Component positioning within the device

Standard battery

Non-custom battery included for reduced cost BOM, so it is located in the largest space in the device

Charging point

The charging point must be connected to the circuit board and the battery. Therefore, it is easiest to put the USB-C female port at the front of the device on the circuit board and then connect the batteries to the circuit board



Vibration motor

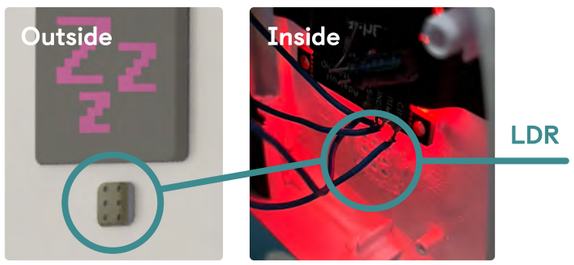
Vibration motor separated from PCB to avoid damage from the vibrations. User should feel vibrations when they hold the device, so the vibration motors should be either side on the hand grips

Buttons

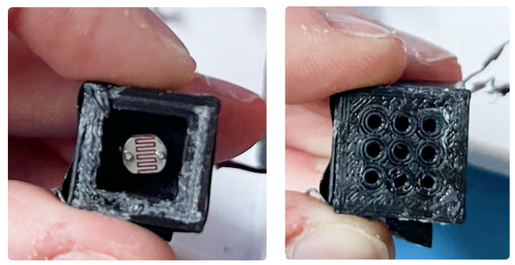
The buttons extend over the edge of the circuit board but all the contacts are placed over the circuit board so they still function properly

Combining the matrix and LDR

We tested the components together in the casing. The LDR did not respond to the hand covering it when the matrix display was on. This is because the light from the matrix had a greater effect on the brightness than the hand blocking the light out. Therefore, a black box was made for the LDR. This protected it from the matrix light and only exposed it to the outside light. For the actual manufactured device the display will be recessed into the case so this light dissipation will not be a problem



Problem of light leaking out the sides of the matrix

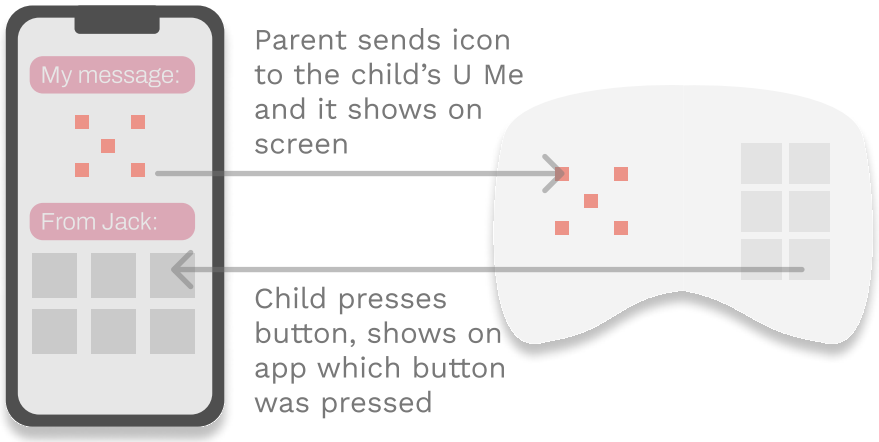


LDR black casing (has a lid with holes in that match holes on the outer casing)

Electronics Development

What should each part communicate

Before starting to code, it was important to understand what needed to be communicated:



App-device communication channel

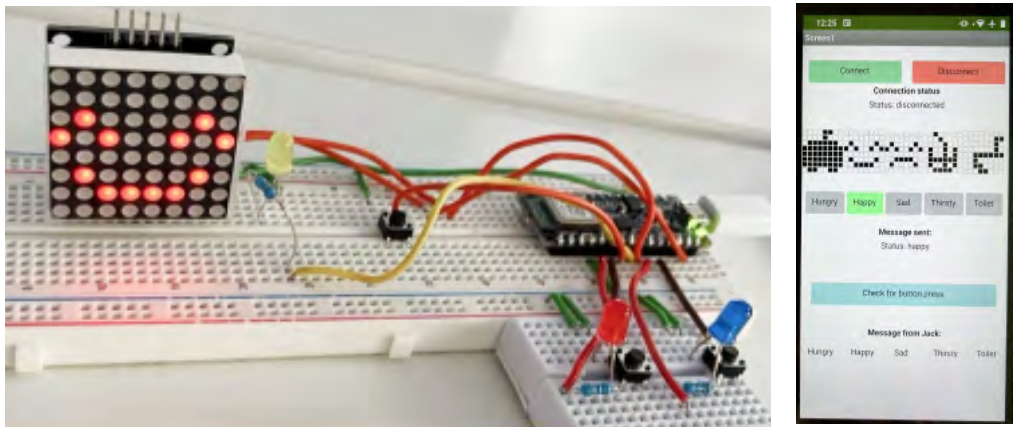
There are different ways the app and the device could wirelessly communicate. These included WiFi, infrared, Bluetooth LE, or even, a custom radio protocol. After considering the pros and cons of each method we decided to use Bluetooth LE since it was the most appropriate (range - it should work within a household environment, power consumption, readily available components, low-cost, multi-connection). It was also readily implementable (off-the-shelf libraries available).

We decided to go for an integrated **Bluetooth-hardware** solution since it had a more compact form factor necessary in our small handheld device. This was instead of using a larger microprocessor with an HC-05 Bluetooth serial transceiver. We bought and programmed an **Arduino Nano BLE** and used the Arduino BLE library to communicate with the app.

Build-code-test-iterate

After a lot of coding and testing cycles we developed a **custom app** in MIT App Inventor [13] with the Arduino Nano BLE. This could send and receive data to and from each other. Once the lines of communication where open we added more features so that:

- LEDs lit up when child pressed a button on the device
- When the adult set an icon from the app, the dot matrix displayed this icon
- Vibration motor buzzed with an incoming or outgoing message from the device
- LDR (light-dependent resistor) sensors were programmed to turn off the display if covered it was covered

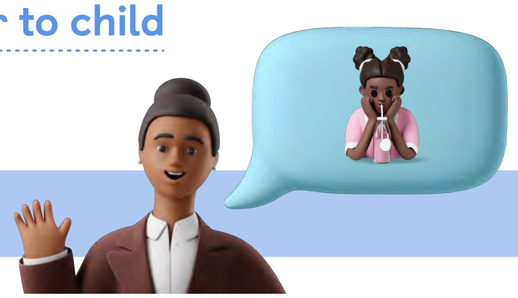


Circuit and functioning app

App development

The U Me app must be simple, intuitive and easy to accomplish tasks with. We spoke with multiple parents in order to develop the UI of the app in a manner that they will find useful and engaging.

Carer to child



Jessy's mum wants her to come for a snack

Jessy is distracted and is not listening to her mum

Her mum sends a notification to the U Me

An image appears on the matrix display

Jessy sits down for her snack

Child to carer

Sophie is thirsty and wants a drink

She gets her U Me device....

... and presses the drink button

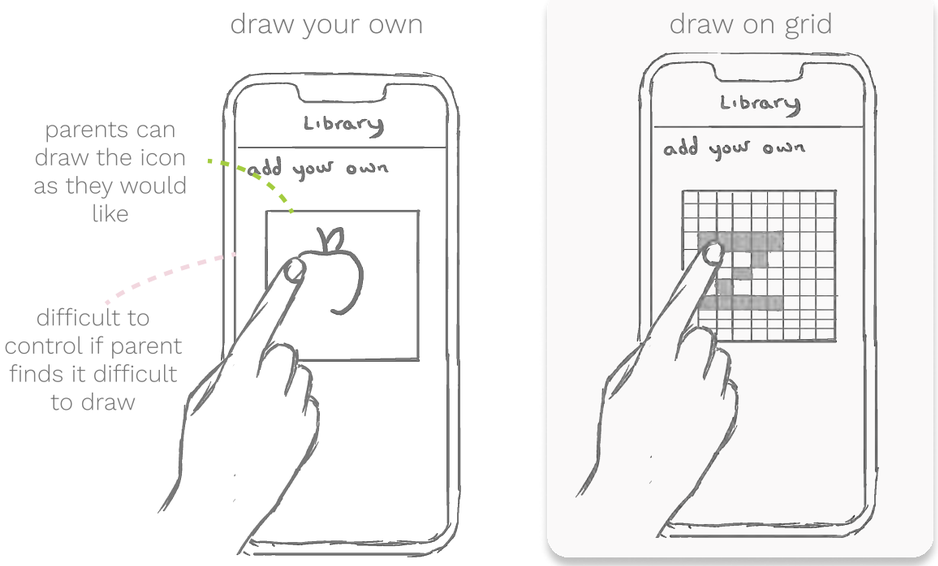
Her carer reads the notification on the app

Sophie gets her drink

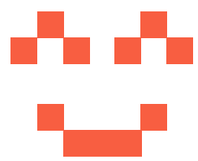
Draw Your Own Icons

"Sometimes, I need to say very specific things, like 'let's go to therapy'. How could I do that?"

Parents sometimes need to set very specialised instructions, which cannot be preset. Therefore, there needs to be an option where parents can add their own icons. After looking at 2 possible options for how the icons could be added, we decided it would be best if the parents could draw it on a grid.



U Me character

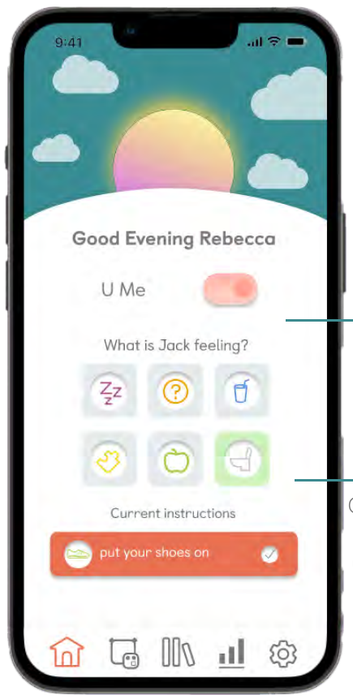


The U Me character can be enabled in the app and will be displayed on the pixel screen. It will make expressions when a task has been completed, in order to validate the user.

"A sweet idea. It's appealing to the child, they'd be interested in having a character involved. It also makes it almost like the child's tool and gives it a real sense of ownership."

The U Me App

From the user journey on the previous page, we developed the app UI that works with this user journey.

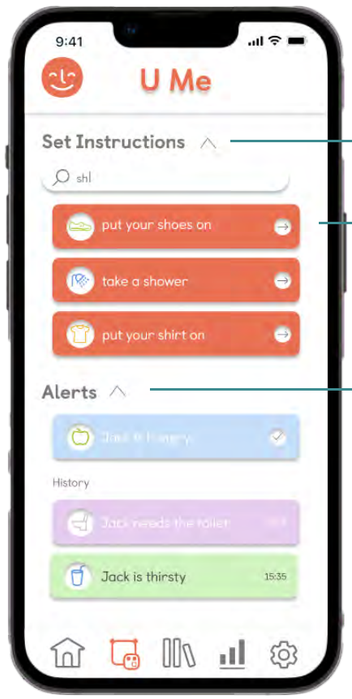


Alerts

Alerts the child sends will light up on the app

Instructions

Current instructions will also show up on the parent's app



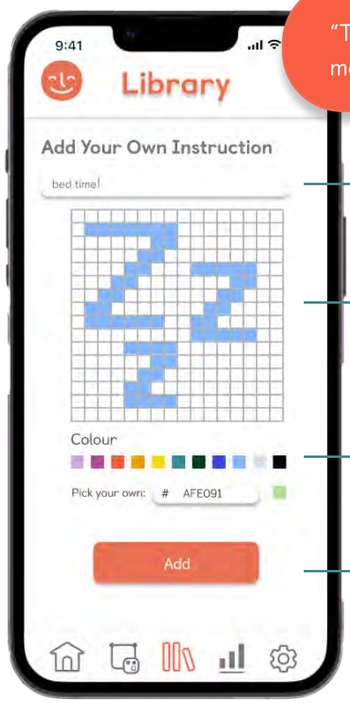
Instructions toggle

Search

The parent can search for the instruction that they want to send to the U Me

Alert toggle

Any current alerts will show, with a tick so that the parent can cancel it once they have attended to it



"This looks great! It's so clear and obvious to me how it all works"

Instruction heading

Parent can add their own instruction titles

New icons

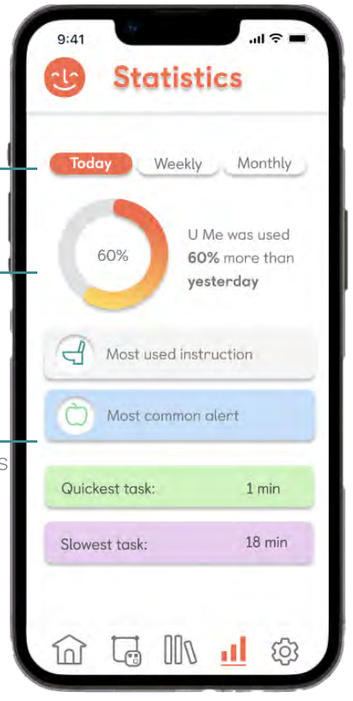
Parent can draw custom icons on the grid

Colour

The parent can choose the colours for the icon

Add to library

Adds the instruction to library so it can be sent to the U Me



Time period

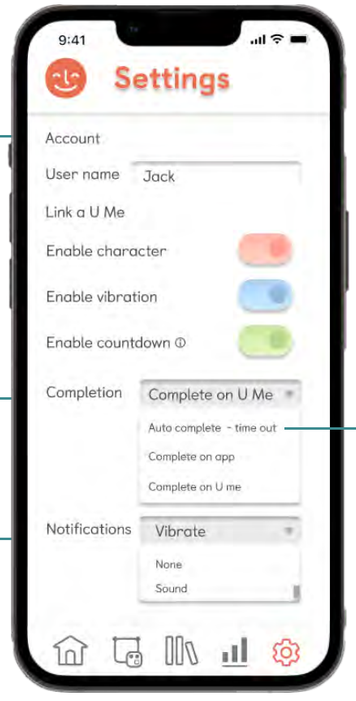
Choose time period for viewing statistics

Overview

General overview of usage

Specific stats

View specific statistics based on instructions and alerts



Account

Parent can set up their own account on the app

Completion

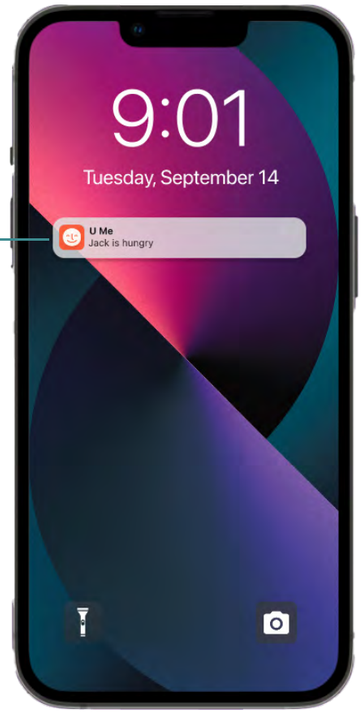
Carer can set how they would like a task to be set as completed

Notifications

Carer can set how they would like to be alerted

Time out

The time out is set to 10 minutes



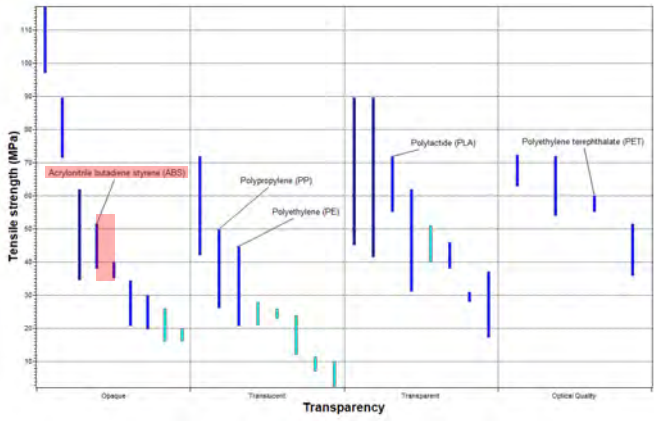
Notification

U Me alert will show up on lock screen of phone

Digital Testing - Material Selection

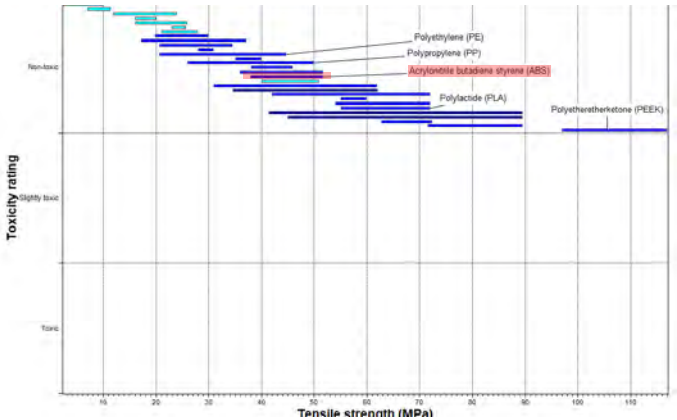
In order to select the most appropriate material for our device, several factors were plotted and analysed using CES EduPack software. Level 2 Polymers and Elastomers were used for ease of manufacture (injection moulding) and their desirable properties. [5]

Comparing Tensile Strength (MPa) to Transparency



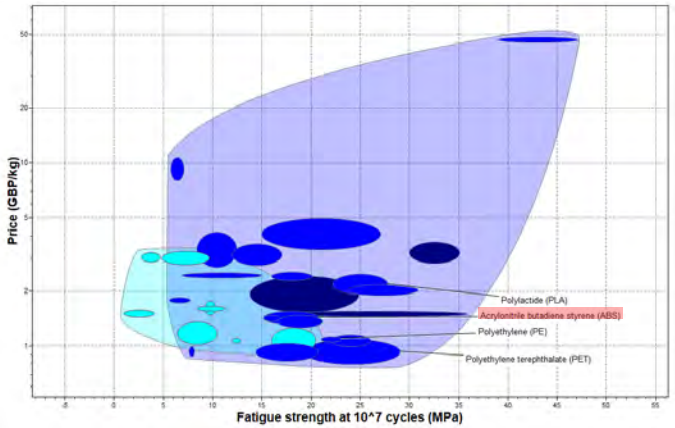
Transparency was compared to tensile strength, with the ideal material being both opaque and having high tensile strength. ABS is suitable since it is also injection-mouldable.

Comparing Toxicity rating to Tensile Strength (MPa)



Non-toxic materials are essential for our children's device, fortunately all of the materials fulfilled this criteria.

Comparing Price (£) to Fatigue Strength (MPa)



Price was compared to the fatigue strength with the aim of the chosen material being as cheap as possible whilst having high fatigue strength. ABS has relatively high fatigue strength and is cheap to injection mould.

ABS is our selected material due to its formability, tensile and fatigue strength, opacity and price. It's also non-toxic and commonly used in children's toys.

Digital Testing - FEA

In order to understand the stresses that would fall on the product, a finite element analysis of the U Me was carried out.

Materials

We believe that Yoto uses ABS or HDPE to make their players, so these two materials will be compared. Their properties were assessed in order to find which one would be a better option.

Material	Pros	Cons
ABS	• **high impact resistance** • **heat resistant**	• scratched easily • environmental impact (oil based, harmful fumes)
HDPE	• resilient • affordable • high stiffness • high strength • lightweight • durable	• highly flammable • non-biodegradable • hard to dispose of

material property	ABS	HDPE
max temperature	60 - 93	120
chemical resistance	poor to fair	good to excellent
tensile strength	**6600 psi**	3200 - 4500 psi
flexural strength	270 - 380,000 psi	145 - 225,000 psi
impact strength	**3.0 - 7.5 ft-lb/in**	0.4-4 ft-lb/in

Based on the criteria that we deemed the most important (tensile strength and impact strength), we decided to choose ABS since it had a higher tensile/impact strength. It would therefore have a better impact resistance if the device was dropped.

FEA

Several FEA analyses were conducted, each looking at different parts. The first was a **drop test**, looking at the stress that would be felt by the U Me if it was **dropped in different ways**. **Finite element method**, FEM, was used to understand the stresses that would be felt by the buttons when pressed.

Drop Test

It was assumed that the device was **dropped from a height of 1m**. This was based on the fact that the average height of an 8-year-old child is 1.28m. It was assumed that the device casing and screen would be made out of **ABS**. 2 positions were tested - one where the device **falls on its front face**, and the second where the **device falls standing upright**.

Button Press

It was assumed that a force of **9N** would be applied (average force of the finger pushing something). The boundary conditions were set to ensure that there was **no rotation in either the x or y directions**.

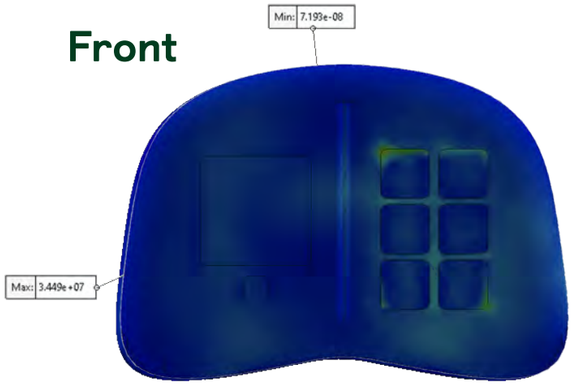
Digital Testing

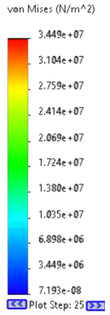
A finite element analysis of the final CAD model was conducted and used to further refine our design to optimise its strength and durability, whilst minimising cost and wall thickness. Both drop testing and stress analysis was carried out.

Drop Testing

Three static studies were conducted, showing the stress plots if the U Me were to be dropped in different positions.

Front



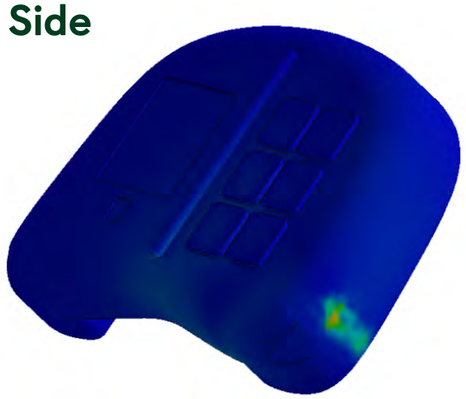


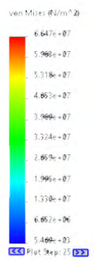
If the device were to be dropped on it's front face, the maximum stress it would experience would be **34.49 Mpa**. This stress would be experienced on the buttons, while the rest of the device would experience a stress of almost **0 MPa**.

Base

If the device were to be dropped on it's base, the maximum stress it would experience would be **33.98 MPa,** on the base on the device. A majority of the device would be experiencing a stress of 0.038 MPa.

Side

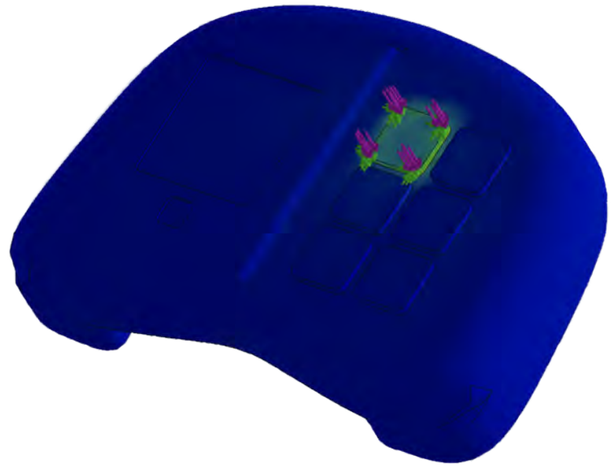


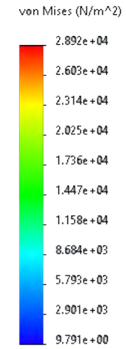


If the device were to be dropped in on its side, the maximum stress it would experience would be **66.5 MPa**, on the side corner of the device. A majority of the device would be experiencing a stress of **0.055 MPa.**

All are below the yield strength of ABS, showing that it would be able to withstand being dropped from a 1m height.

Button Press





A child would press a button with an average of 9N per finger. The maximum stress on the button, once a force of **9N** had been applied, is 0.02892 MPa. The button would be able to withstand that level of stress

Summary

- FEA analysis has confirmed that our casing design would be appropriate for use (both for pressing buttons as well as enduring impact upon potential dropping).
- Drop testing highlighted the areas of highest stress during impact and led to improving our casing design by reinforcing the side walls with uni-directional ribs.
- All stresses were below the tensile strength of ABS, implying that our device will not fail during use.

Ribs

Based on our FEA studies, particularly the drop testing, our casing design has been optimised and reinforced with uni-directional side-wall ribs. This is to strengthen the sides which are susceptible to higher stresses during impact (e.g. when dropping the device) whilst minimising the wall thickness required.

Power requirements

In order to get an estimate of the power required for the batteries to run the device, some calculations must be done

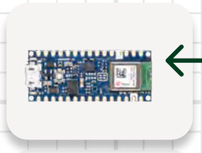
Power Required For Components

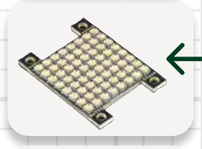
Power = current x voltage

Watt-hours = power x time

Peak load calculations

Realistic load calculations





Component	No.	Operating voltage	Current draw	Maximum power	Max power for 8 hours	Max power for 8 hours, 10% increase	Realistic time on per hour	Realistic power	Realistic power, 8 hours, 10% increase
Arduino Nano 33 BLE	1	3.3 V *	50 mA	0.165 W	1.32 Wh	As recommended by an engineer, we increased the final power value by 10% to account variations in battery efficiency over the battery's lifetime and differences in temperature during use. Both of which will affect the battery's capacity.	60 minutes	0.165 W	1.452 Wh
Bluetooth [12]	1	3.3 V	5 mA per signal 5 signals/hour = 25 mA	0.0825 W	0.66 Wh		60 minutes	0.0825 W	0.726 Wh
Adafruit dotstar	1	3.3 V	~ 500 mA, to account for losses → 750 mA	2.475 W	19.8 Wh		30 minutes	1.238 W	10.89 Wh
RGB LED	1	3.3 V	50 mA	0.165 W	1.32 Wh		40 minutes	0.110 W	0.968 Wh
Vibration motor	2	3.3 V	110 mA per motor, due to inefficiency in motors due to heat loss a 50% loss in current will be assumed → 165 mA	1.089 W	8.71 Wh		5 minutes	0.091 W	0.801 Wh
(assuming resistors and LDR have negligible current draw)	Total		1205 mA	3.98 W	31.81 Wh	35.00 Wh	N/A	1.687 W	14.84 Wh

8 hours was chosen since it is a good compromise between user convenience and batteries not taking lots of space in the device.

Final value

Battery Requirements

- Battery must be rechargeable as using a cable to charge the device is more convenient for users than replacing batteries. It also gives the child more independence to charge the device themselves
- Battery should be a lithium-ion battery as they can be recharged many times and are sufficiently robust which is important if the child drops the device
- Off-the-shelf battery should be used for a lower cost BOM. Due to the dimensions of the device casing, a 18650 battery should be used
- Ideally there should only be one battery so it is light for children to hold

Battery Calculations

To find the right battery, we did some calculations using the realistic power final value. The 3.7V from the battery will go through a linear regulator to step down the voltage to 3.3V for the Arduino. The linear regulator is running at 89% efficiency ((3.3/3.7)x100)

Lithium-ion battery

Nominal voltage: 3.7 V
Battery capacity: 2200 mAh
Each cell has a capacity of:
3.7 x 2.2 = 8.14 Wh
After going through linear regulator:
8.14 x (3.3/3.7) = 7.26 Wh

For our device:

14.84/7.26 = 2.04 = rounds to 2 batteries

It would be better if there was just one battery, therefore the battery's capacity should be roughly doubled

Decided to use another Li-ion battery with a higher battery capacity

Nominal voltage: 3.7 V
Battery capacity: 4500 mAh
Each cell has a capacity of:
3.7 x 4.5 = 16.65 Wh
After going through linear regulator:
16.65 x (3.3/3.7) = 14.82 Wh

For our device:

14.84/14.82 = 1.001 = 1 battery can be assumed to work for this. This off-the-shelf battery is perfect for our device

Device Specification

Device technical information, using the peak load calculations

Power rating	4.45 W
Voltage input	3.7 V
Maximum current rating	1.20 A
Battery	4500 mAh
Battery life	8 hours

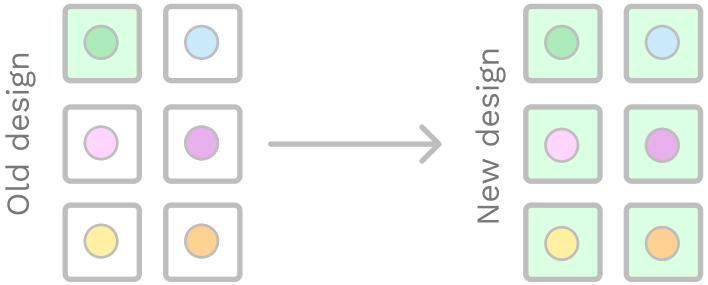
Time it lasts for realistic power consumption (this number is roughly halved to 4 hours if using peak load)

* The Arduino Nano 33 BLE can be configured to run on a 3.3VIN by disconnecting the MPM3610 voltage regulator [12].

Power & Load Considerations

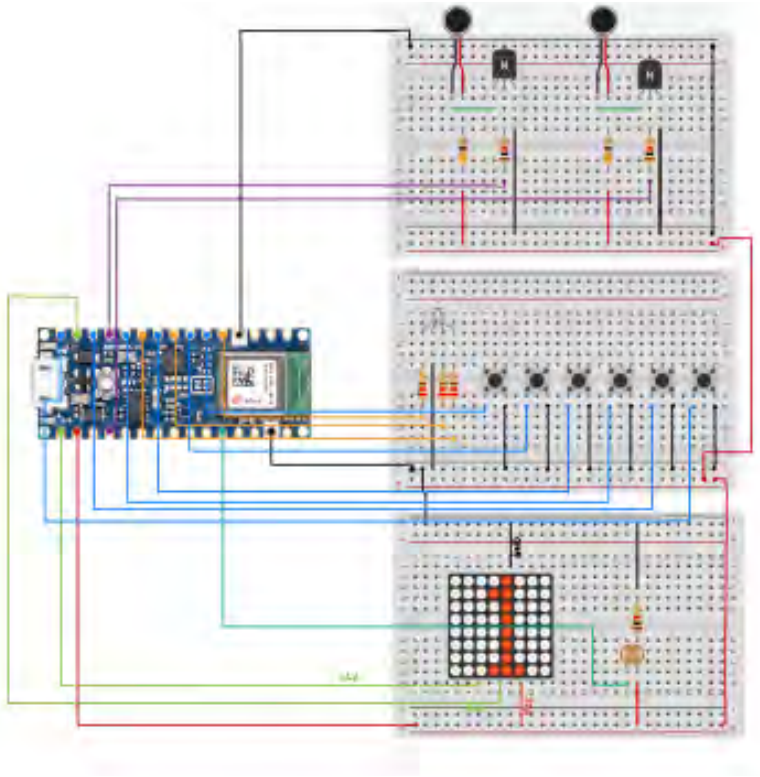
In order to calculate the battery required, we need to consider the power and load on the components in the circuit.

We iterated on our circuit to reduce the power required. We decided to use 1 RGB LED to light the whole button panel rather than 6 LEDs backlighting each button (see diagram below). Users said that their children could easily be accustomed to associate a colour with a word/task. So having the whole panel light up would make it clear to the child which button has been pressed. Having fewer LEDs also allowed for an easier assembly process, and a more affordable BOM.



We also sequenced the vibration motor and matrix display/RGB LEDs to further reduce the load on the battery. The vibration motor buzzes, stops and then the LEDs light up. However for the calculations in order to peak current, the components are assumed to fire all at the same time.

The circuit required for the device is shown below:



Finding the appropriate length of time the device should work for

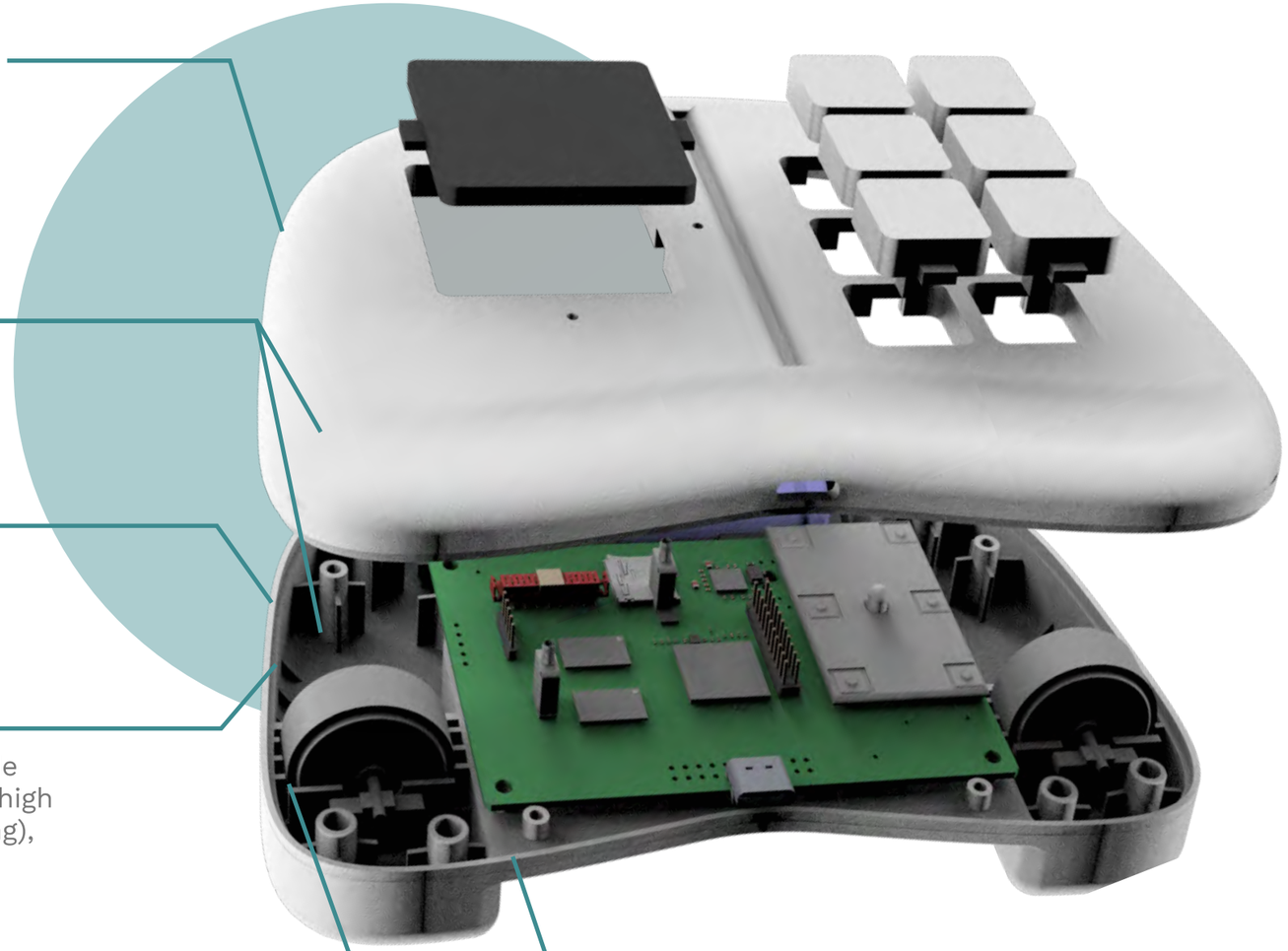
After talking to users, we estimated the time the device would be used per hour for the power requirements portfolio page.

- We decided there would be no more than **5** separate communications between the carer to child or child to carer
- The app is programmed to cancel the adult's message on the screen of the device after **10 minutes**. Therefore, the matrix display will not be on for more than **30 minutes** (the parent will not send more that three instructions to the child per hour to prevent the child from being overwhelmed).
- The child's RGB LED will not be on for more than **40 minutes per hour.** Even if the child sends 5 requests to the adult, the light should not be on for more than **8 minutes**. The adult should answer their request quickly in order to reinforce the idea to the child that when you use the device to say something, the adult will respond.
- The vibration motor will only be on for less than a minute since it vibrates for less than a second at each request. However this has been increased to **5 minutes** for the calculations to ensure that the system is not underpowered.

DFMA

Detailed Design

Various Design For Manufacturing and Assembly (DFMA) considerations were incorporated into the design.

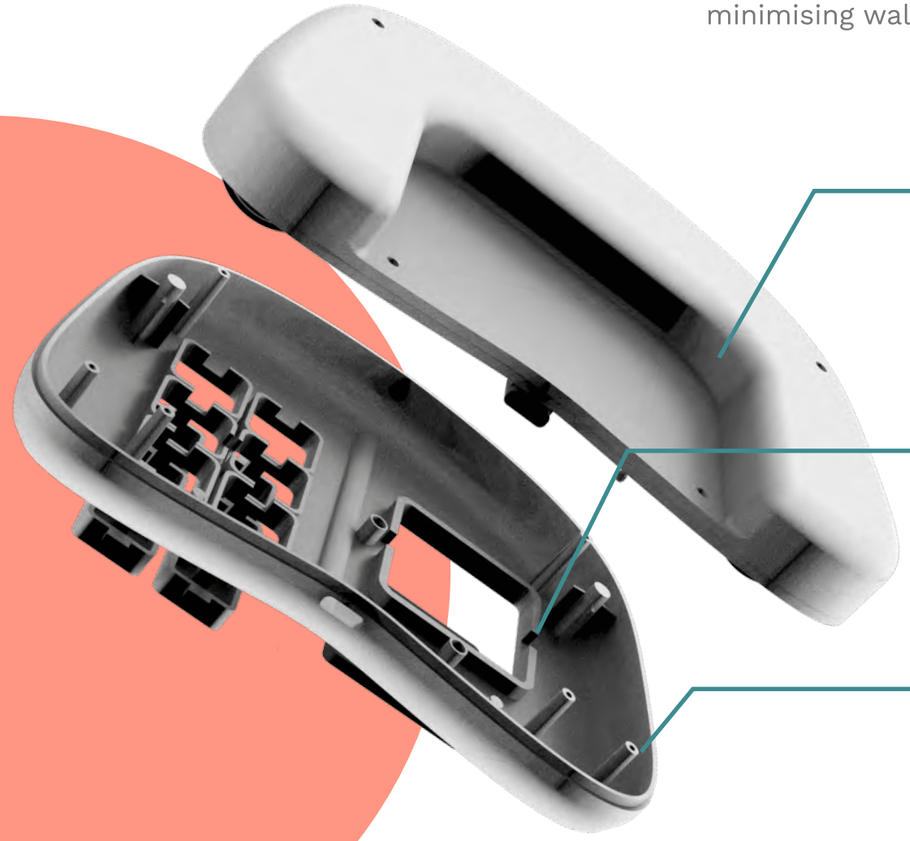


Filleting
All bosses and sharp edges/ corners were filleted to reduce stresses and improve manufacturing results.

Two Shells
Main casing split into 2 halves, with careful consideration into the position of the split-line.

Lip/groove
Applied to the 2 shells to provide good joining between casing halves to aid assembly.

Unidirectional Ribs
To reinforce and strengthen side walls (susceptible to potential high stresses during impact/dropping), minimising wall thickness.



Rounded Corners
Rounded edges were applied to corners to reduce stress concentrators, provide uniform wall thickness and improve plastic flow.

Steps + Slots
Combined into the design for ease of assembly and securing parts in place.

Bosses
Incorporated into the casing design at different heights due to the shell's form.

Uniform Wall Thickness
Consistent wall thickness to provide uniform cooling, avoid shrinkage and increase cost-efficiency. Wall thickness within guided range for all components.

Transitions in wall thickness (where present) were gradual by radius, and commonly 2.5 mm.

Ribs
Added to strengthen the bosses and case the vibration motors- allowing wall thickness and material deformation to be minimised. Rib thickness is 50-75% of the wall thickness.

Detail Design

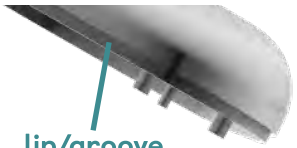
Detailed analysis was conducted in order to evaluate our design, optimising it for manufacture and assembly. Various guidelines have been followed and highlighted below.

DFM Design Rules

Various DFM design rules have been applied and obeyed when modelling our product. This minimises many factors such as manufacturing errors, inaccuracies, cost and time.

Wall Thickness

- 0.75 mm to 3mm for reinforced materials
- 0.5 mm to 5 mm for unreinforced materials
- Gradual transition for non-uniform thicknesses



lip/groove

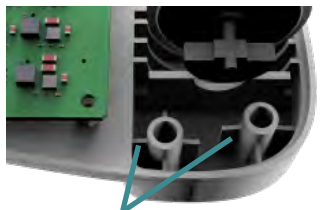
smooth transition in wall-thickness

uniform thickness (2.5 mm)

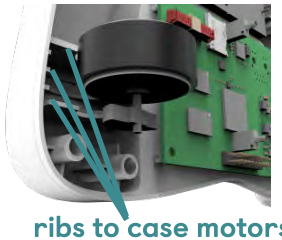
Ribs

- Ribs are tapered to improve ejection
- The fillet radius is be 40-60% of the rib thickness
- Maximum rib depth is up to five times the rib thickness
- A normal junction is used with ribs that are less than 0.75 times the wall thickness (t).
- Recommended draft angle of 1 degree is used.

tapered ribs [11]

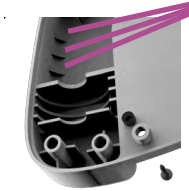


normal junctions (<0.75 x t)



ribs to case motors

Gussets

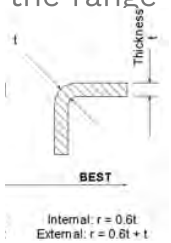


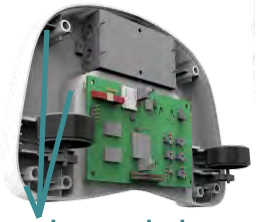
uni-directional side-wall gussets

- Uni-directional ribs/gussets are spaced apart by at least 2 times more than the nominal wall thickness as guided.
- Reinforces side walls susceptible to impact stresses (when dropped)

Corners

- Optimal corner design: Internal r = 0.6t, External r = 0.6t + t
- Internal radius should be at least half the wall thickness (t) and in the range 0.6 to 0.75 times the wall thickness.

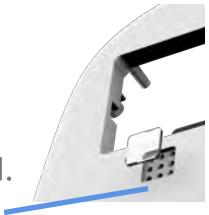




filleted, rounded corners

IP Electronics Protection

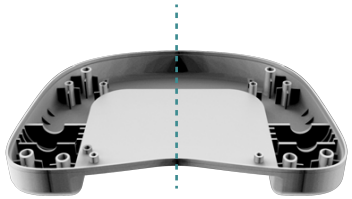
- Thin acrylic sheet designed to cover the light sensors whilst allowing light through.
- The device is hence waterproof, dust-proof and has an improved IP rating and safety for the child.



sealed/protected electronics

Symmetry

- Casing design has been simplified and made symmetrical where possible
- Vibration motors, ribs, bosses and central placement of the PCB are all symmetrical on the lower shell.



Using Boothroyd Dewhurst DFMA standards for evaluation

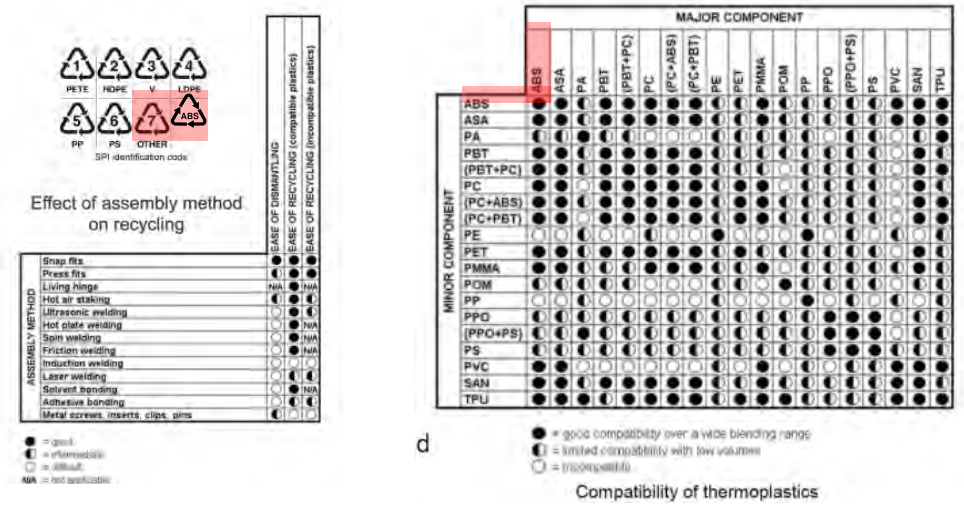
We can't use the DFMA software but we rated our product against some of their standards:

Poor		Good
long handling time	●●●●●	short handling time
2 hand usage	●●○○○	1 hand usage
messy electronics	●●●○○	tidy electronics
poor chamfer design	●●●●●	good chamfer design
tools for disassembly	●●●○○	no tools for disassembly
heavy	●●●●●	light
long insertion time	●●●○○	short insertion time

Detail Design

Recyclability and Part Replacement

- Compatible materials are used together to minimise dismantling and sorting.
- Material of manufacture will be marked on all plastic parts, using standard symbols and abbreviations.



The U Me was designed to allow users to replace and recycle multiple parts at its end of life. The assembly method is simple and disassembly (when changing batteries or replacing parts) is easy, whilst also making it inaccessible for the child.

Removal of the battery casing (via a screw and reversible snap fit) allows users to simply replace the batteries. Removal of the casing halves is made harder since the product is not intended to be disassembled during its life cycle.

Several parts are made from ABS plastic which can be recycled and blended, as shown in the chart above. Screws can also be recycled as they are manufactured from steel.

Parts for landfill have been minimised where possible, with remaining parts including the PCB and vibration motors.

Aesthetic Design

The Yoto U Me has a visual design highly aligned to the Yoto products, with their vibrant colours, pixel screen and soft touch. CMF is consistent with the Yoto brand.

A silicon case has been designed for customisability, whilst also providing a soft touch for the user and shock absorbing properties during impacts.

As with the Yoto player, Yoto branding (logo) has not been applied to the external casing. Markings were applied to the base of the device (lower shell) to provide the required information to the user whilst not affecting the product's aesthetic.

Injection Moulding Analysis

- Wall thickness 0.5 - 3.0 mm, discontinuities will results in sink marks- this has been avoided.
- Draft angle of 0.5 - 1 degrees used to minimise cycle times
- Internal radii 25 - 60 % to increase strength (not notch sensitive)
- Low shrinkage material used
- Tolerances have been carefully considered for the dimensions of holes, fits, slots to account for machining inaccuracies. Mostly 0.2 mm tolerances have been used.

Product Assembly Process

The product has been designed for easy assembly and manufacture, not requiring specialist tools.

Assembly Process

1. Base shell

The lower casing/shell is the centre of the assembly.

2. PCB

The PCB can be fixed via 4 mechanical screws to the mounts on the lower casing.

The LED/buttons electronics sub-assembly can be mounted onto the PCB.

3. Charging Port

The charging port (on the PCB) can be simply inserted into the product base casing via the slot.

4. Batteries + Casing

The batteries can be inserted into position in the battery casing contained and fastened within the lower shell.

5. Screen + Buttons

The screen display, acrylic piece and button caps can be positioned on the top shell via steps + slots.

6. Vibration Motors

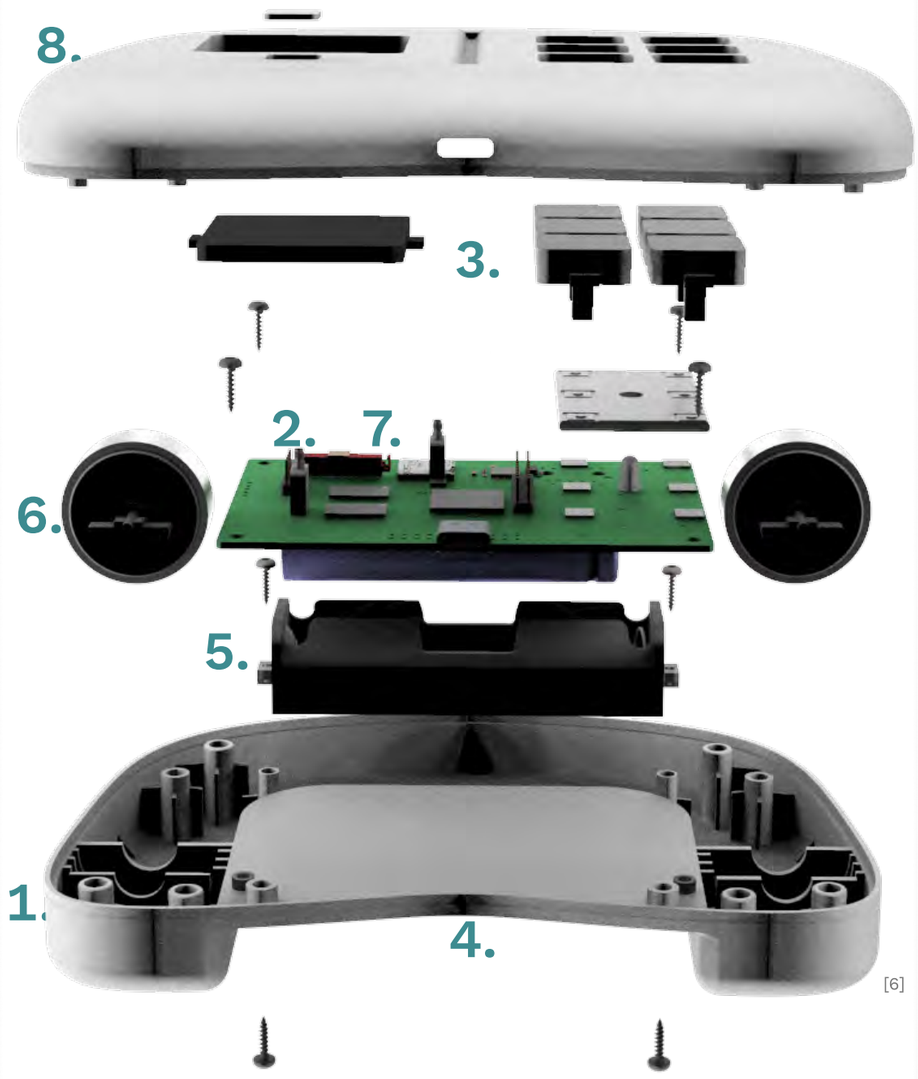
The vibration motors would be cased neatly within the injection moulded ribs in the lower casing.

7. Electronics Wiring

All electronics connected to the circuit board, wires contained neatly to avoid tangling.

8. Top Shell

The upper shell can lastly be attached to the lower shell. Screws and self-aligning bosses will be used to fasten the shells together



[6]

Estimated Cost/Time

DFA Index:

We estimated the DFA Index for the assembly of our device using the above equation as well as the Boothroyd Dewhurst DFMA tool.

DFA index estimation = 26 x 3 / 72 = 1.08
(16 parts + 10 screws = 26)

Assembly Process

1. 3 seconds (initial set-up)
2. 10 seconds (pre-assembled PCB, 4 x M2 screws)
3. 3 seconds (USB-C port)
4. 10 seconds (battery + casing, 2 x M2 screws)
5. 15 seconds (6 x buttons + 1 x screen)
6. 6 seconds (2 x 3 seconds per motor)
7. 15 seconds (top shell, 4 x M3 screws)
8. 10 seconds (top shell, 4 x M3 screws)

Total Time

The total time based on these estimates is **72 seconds**. This time will change depending on the manufacturing scale (fully/partly/not automated). Multiplying by an upper bound of 1.5 results in an assembly time of just under 2 minutes. Assuming a worker is payed **$7 USD/hour**, this leads to a unit cost for assembly as **$0.23**, which is at a low cost compared to competitor products. This matches our aim of designing a product that is widely **accessible** and **affordable**.

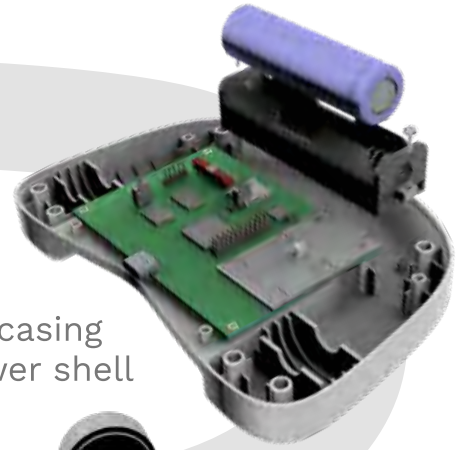
Product Assembly Process

Step by Step Analysis

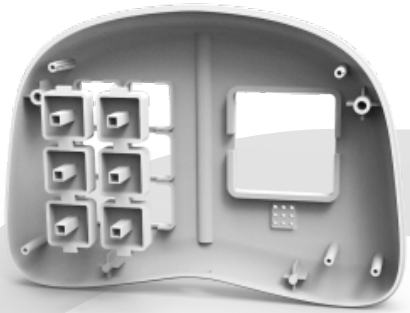
Lower shell acts as centre of assembly

PCB screwed into 4 corner bosses with M3X8 self-tapping screws

Button contacts placed on PCB



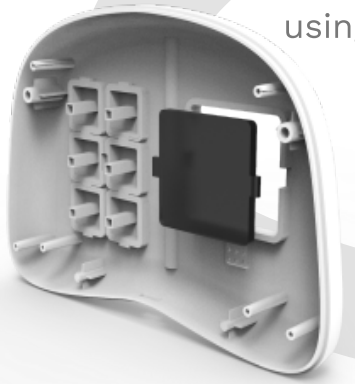
Li battery and casing screwed to lower shell



Buttons put in place using guiding slots

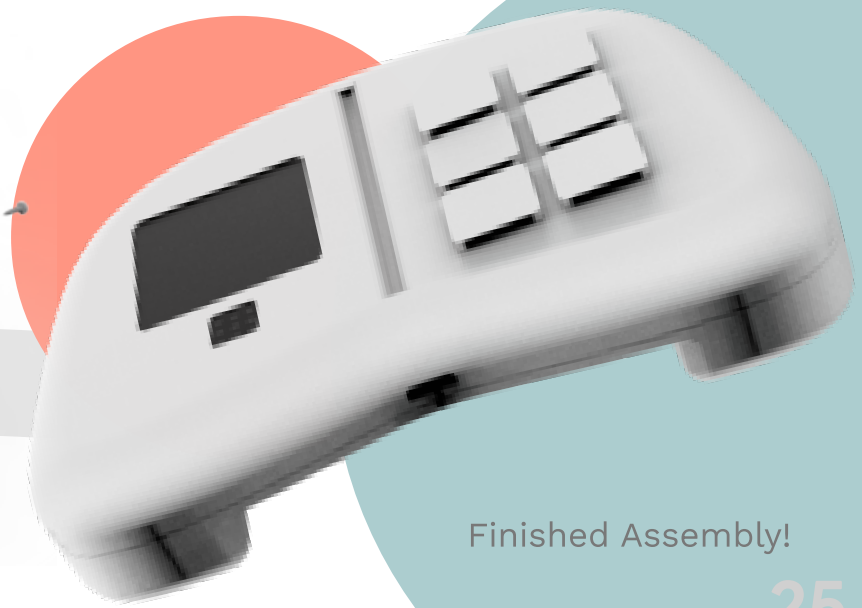
Components wired up to complete lower shell assembly

Vibration motors positioned into ribs



Pixel screen and LDR put in using guiding slots

Top and lower shell attached via 4 self-tapping screws



Finished Assembly!

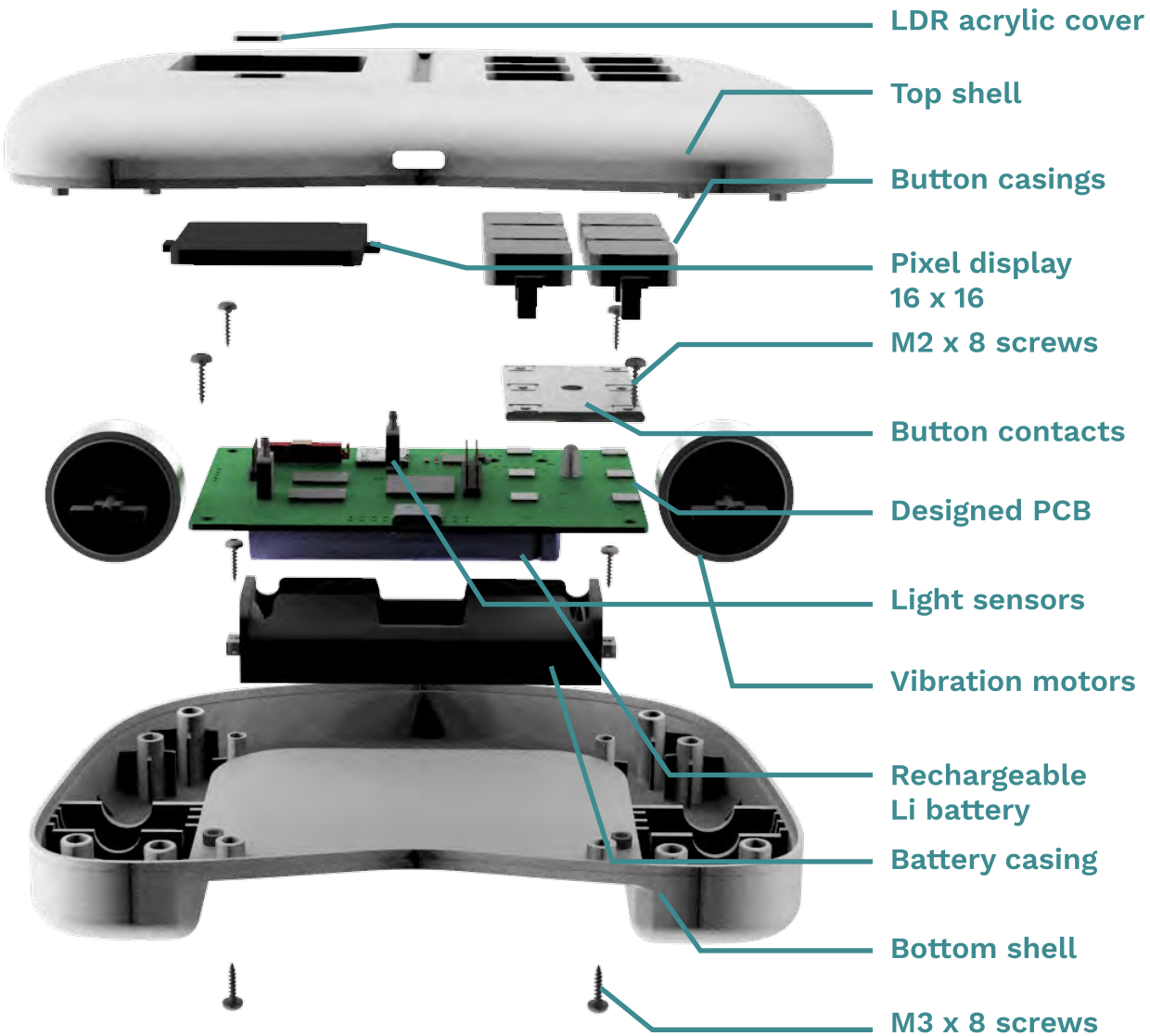
Product Assembly Process

To estimate the price for custom parts, the SolidWorks cost analysis tool was used. It is assumed all parts would be ordered in bulk for mass production (500-1000+), reducing cost of individual parts.

Cost Analysis

The costs of all component in the product were calculated in order to estimate the overall cost. We aim to make our product to be as affordable as possible.

Component List



Manufactured Parts

Component	Price
Top Shell	£3.53
Bottom Shell	£3.21
Button Casings	£0.36 each
Acrylic LDR Cover	£0.13

Standardised Parts

Component	Price
PCB (tailor-made)*	£5-10
USB-C Port	£0.72
Li 18650 Battery	£2.35
Li 18650 Battery Casing	£1.67
Vibration Motors x 2	£0.35 per unit
Matrix Display	£24.00 **
M3 x 8 Screws	£0.06 per unit
M2 x 8 Screws	£0.06 per unit
[7, 8, 9, 10] **Total**	**£44.07**

* includes RGB LED, 6 x button contacts, microcontroller, LDR

** we could not find a bulk-purchase price for the matrix display which has led to it accounting for over 50% of the product price. In reality it could be bulk purchased much cheaper (around 40% average off standard retail price).

Product Compliance Research

In order to sell the product in the UK and EU, a number of regulations must first be met to ensure that the product is of a high quality.

UKCA Marking

The UK Conformity Assessed (UKCA) marking is required in order to sell products in the UK as of 1st January 2021. A number of **technical requirements** must be met, a **conformity assessment** must be carried out, and the manufacturer must sign the **UK Declaration of Conformity**. This demonstrates that the product has been made to a sufficient quality, meaning that it is safe to use and can be marketed. The UKCA mark must be **clearly visible** on the product itself, or if this is not possible, then either on the packaging, or in any of the accompanying documents. It is not permitted for any other mark on the product to reduce the visibility or legibility of the UKCA mark, and they must also accomplish a different function. The height of the UKCA mark must be at least **5mm**, and the mark must always remain in proportion. [14]

CE Mark

Obtaining the CE mark requires the same process as the UKCA mark, but is required to ensure that a product can be sold in the EU (not covered by UKCA). However, the key difference is that, in this instance, the **EU Declaration of Conformity** must be signed. It is evidence that the product meets the health and safety requirements of the European Union, and will allow **free movement** of the product within the European Economic Area. [15]

Documentation

Both the UK Declaration of Conformity, and the EU Declaration of Conformity require the following information: **name, full business address, product id, declaration of compliance, body who carried out conformity assessment, relevant legislation, signature, date of declaration.**

Both also require a **technical file** to be set up. This must be kept for at least **10 years** after the product is placed on the market, and must be available to show to any official on demand. For the UKCA, the file must show: **how the product has been designed and manufactured, how the product conforms to relevant requirements** and the **address of the manufacturer and any storage facilities**. For the CE, the file must show all of the information available in the EU Declaration of Conformity, as well as **labels and instructions of use**, **a list of parts** and any **test results.**

British and International Standards

BSI & ISO

The British Standards Institution and the International Standards Organisation are two bodies which give out standards to companies whose products are of a sufficiently high standard. It is a mark that the products are safe to use and have the benefit of being well-received by the market, and increasing trust in the brand.

The Kitemark is awarded by the British Standards Institution, and is evidence that a product conforms to the required levels of safety and quality. It has become an international mark of quality. [16]

"we quickly found out how widely recognised and respected the Kitemark is, not just in the UK but also in overseas markets

BS EN 71

Unlike a majority of standards issued by the BSI, the BS EN 71 is a compulsory one required for manufacturers of children's toys. The standard ensures all aspects of safety, from flammability to the dangers of children swallowing small parts to them physically injuring themselves on sharp objects. [18]

"to promote best practice and excellence in all aspects of product design, toy safety, ethical manufacturing, environmental issues and responsible marketing and by so doing protect and promote the interests of our members

Product Compliance

FCC mark

The FCC mark is a mark on electronic products that are sold in the USA to ensure the safety and quality of electronic products, as well as ensuring that minimal amounts of electromagnetic radiation are emitted.

UKCA mark

The UKCA mark is required on all products to be sold in the United Kingdom. It is a mark of quality, meaning that the product has been made to a sufficient standard to be safe, and therefore can be marketed.

CE mark

The CE mark, like the UKCA mark, is a mark of quality, and ensures that it is safe to use. It is required in order to sell products in the EU.

ASTM mark

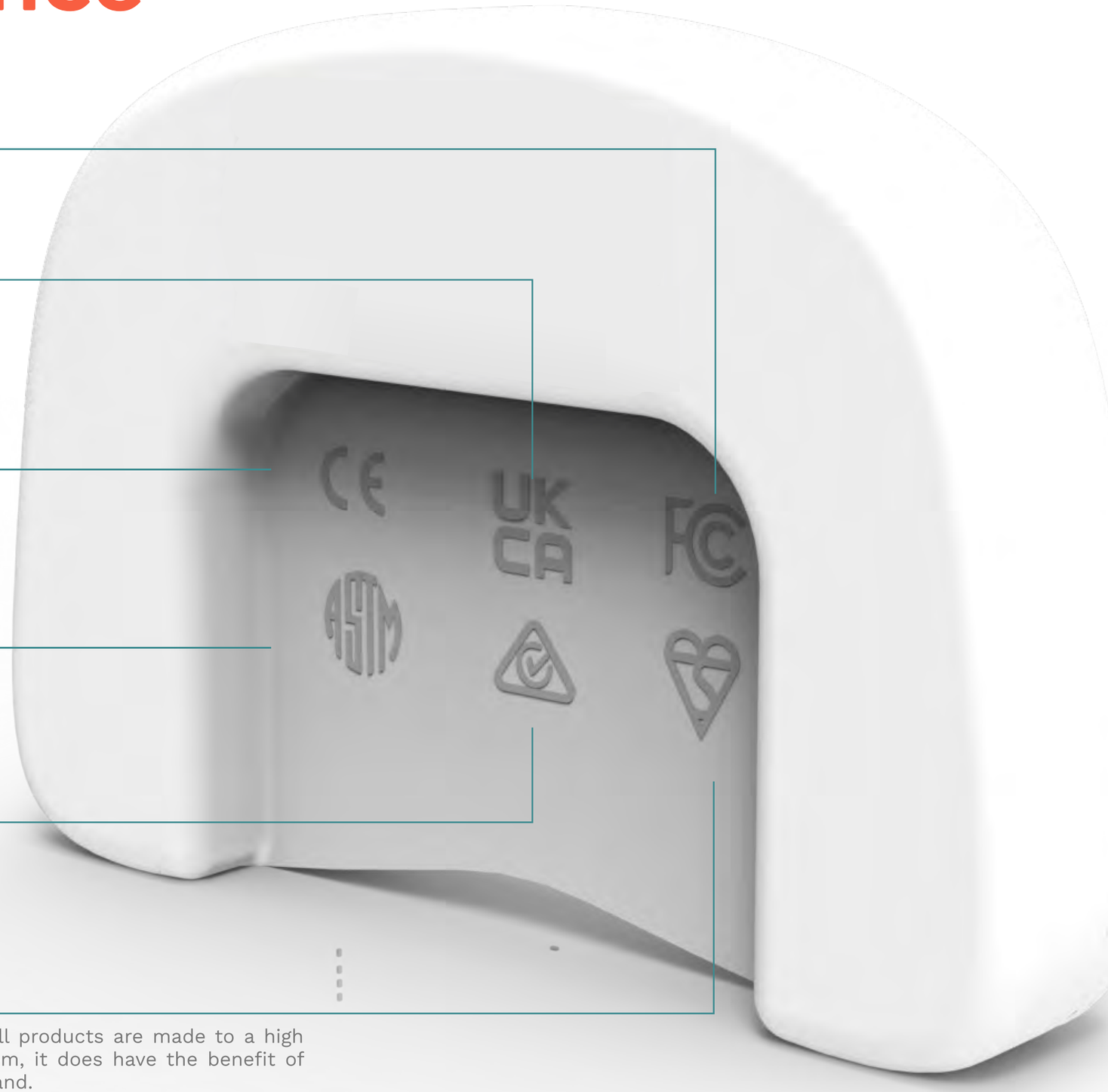
The ASTM mark is a sign that a product complies to the standards set out for children's products by the American Society for Testing and Materials. It is required for children's toys which are going to be sold in the United States of America.

RCM mark

Like the FCC mark, the RCM mark ensures that electronic products are safe to use. The RCM mark is required to sell products in Australia.

Kitemark

The Kitemark is issued by the British Standards Institution, ensuring that all products are made to a high quality. While it is not a requirement to sell products in the United Kingdom, it does have the benefit of reassuring users of the high quality, as well as increasing market trust in a brand.



Product Compliance Regulations

Yoto conform to some set standards depending on the region that the product is being sold in. In order to sell their products in the UK, they have to also ensure adherence to some set laws.

Yoto Product Safety [17]

All Yoto products conform to the standards listed below.

BS EN 71, ASTM, ISO

Every region where Yoto sell it's products have their own toy safety standards that need to be met. These are: BS EN 71 in the UK and the EU, the ASTM in the USA and the ISO in Australia. All of these standards accomplish the same aim, ensuring that all products which are for children are safe to use, and are of a high quality.

CE

In order to sell Yoto products in the EU, they all hold the CE mark. This indicates that they conform to the health, safety and environmental protection standards set out by the EU.

FCC & RCM

Both the FCC and the RCM marks are certification marks required on electronics products that are manufactured or sold in the USA (FCC) or Australia (RCM). They both ensure the safety and performance of electronics devices. The FCC mark ensures that any electromagnetic radiation emitted from a device is below the limits specified by the Federal Communications Commission.

RoHS & REACH

RoHS (Restriction of Hazardous Substances) and REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals) are two environmental regulations for hazardous materials. [21]

General Product Safety Regulations 2005

The General Product Safety Regulations 2005 require all products to be safe in their normal or reasonably foreseeable usage and enforcement authorities have powers to take appropriate action when this obligation is not met.

Supply of Machinery (Safety) Regulations 2008

The Supply of Machinery (Safety) Regulations 2008 states that no responsible person will put machinery on the market or put it into service unless it is safe

Toy Safety Regulations 2011

Toys, including the chemicals they contain, must not jeopardise the safety or health of users or third parties when they are used as intended or in a foreseeable way, bearing in mind the behaviour of children.

Restriction of Hazardous Substances 2012

The Restriction of the Use of Certain Hazardous Substances in Electronic and Electrical Equipment Regulations 2012 restrict the use of certain hazardous materials (lead, cadmium, mercury etc.) in the manufacture of various types of electronic and electrical equipment.

Ecodesign for Energy Related Product Regulations 2010

The Ecodesign for Energy Related Products Regulations 2010 aim to improve the environmental performance of products throughout their life cycle, starting at a very early stage in their design. [22]

Electrical Equipment (Safety) Regulations 2016

The Electrical Equipment (Safety) Regulations ensure the safety and performance of all electrical equipment.

Product Labelling

All products that are sold in the UK or the EU must have a number of labels on either the product itself or on the packaging, all of which accomplish different functions.

Product Labels

CE mark

The CE mark must be visible, legible and indelible. Both letters should have the same vertical height, and be no smaller than 5mm.

UKCA mark

The UKCA mark must be easily visible and legible. Like the CE mark, it has a minimum height of 5mm. Even if made larger, the letters of the mark must remain in proportion.

FCC mark

The FCC mark and ID must be visible on the product. It can be a label or etched in, but must be clearly visible and in a font or size that is reasonable without magnification.

ASTM mark

The ASTM mark should be placed either on the product or as part of its instruction manual.

RCM mark

The RCM mark must be legible and visible to the unaided eye. It may be in any colour, as long as it remains visible. It must be no smaller than 3mm in height

Kitemark

The BSI Kitemark must be displayed with the BSI Kitemark License Number and Product Standard Number displayed, using Tahoma font. They must all be the same colour.

Packaging Labels

Not for Under 3

The age restriction warns parents to keep children under 36 months away from the product. This is typically because of small parts within the product which can become smoking hazards.

On Pack Recycling Label

Since the packaging is made of cardboard, the OPRL mark should be put on the label. It indicates that the packaging can be collected for recycling or if the user must take it themselves to the local recycling centre.

Bluetooth

Bluetooth is used so that the app and the U Me are able to communicate - and therefore the Bluetooth icon must be placed on the packaging.

ABS

All plastic components (particularly upper, lower casings and buttons) will be labelled on their inner surface to identify what plastic it is. We have used ABS.

Safety Warnings

WARNING! Misuse of transformer can cause electric shock. Not to be connected to more than one power supply. Small parts, Choking hazard. Long Cord. Strangulation hazard.

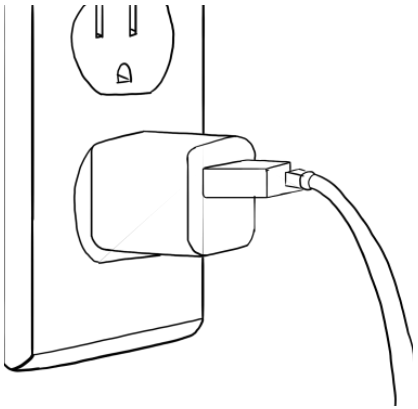
User Guide

In the packaging of the U Me, there will be an accompanying user guide for the parent to read, so that they are able to use the product and the app properly.

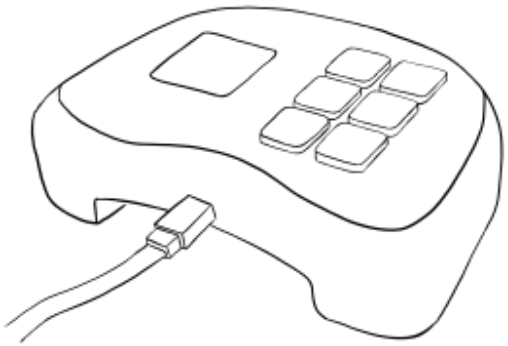
Styling Justifications

- Simple contour line sketches have been used to match Yoto's style.
- Steps begin with verbs/imperatives to clearly convey information.
- Black and white style for consistency, clarity and ease of printing.

Charging the U Me



Place plug in socket



Place USB-C end in the U Me

The U Me App

To pair the U Me and the app:

1. Download the U Me App
2. Navigate to Settings
3. Click on Link a U Me
4. Click Add New Device
5. Wait until U Me appears in options
6. Click U Me option
7. Wait for 5 seconds

Using the U Me

1

On the U Me app home page, toggle the U Me on

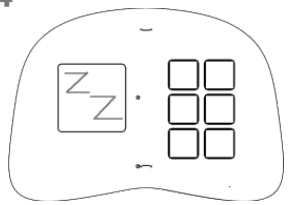
2

In the U Me app settings, set the completion method

3

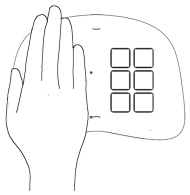
Navigate to the U Me page, and set an instruction

4



The icon of the instruction will appear on the screen of the U Me

5

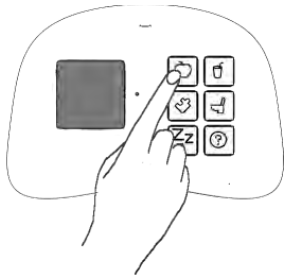


If complete on U Me is completion method, the child can cover the screen with their hand to complete task

6

If complete on app is completion method, press tick on home screen to complete task

7



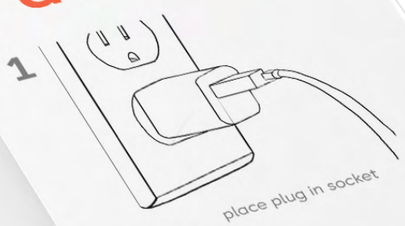
Child can press button on U Me to send alert to parent

8

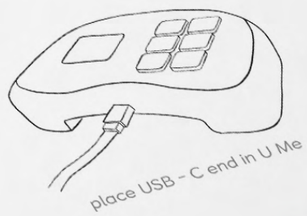
Alert will show up on U Me app

User Guide

1 Charging a U Me



place plug in socket



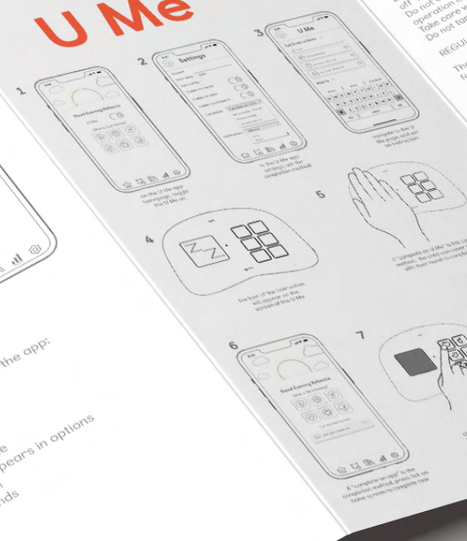
place USB - C end in U Me

2 Link a U Me

To pair the U Me and the app:

1. Download the U Me App
2. Navigate to Settings
3. Click on Link a U Me
4. Click Add New Device
5. Wait until U Me appears in options
6. Click U Me option
7. Wait for 5 seconds

3 Using the U Me



4 Safety

INSTRUCTIONS FOR SAFE USAGE

Do not operate if broken and/or damaged
To avoid malfunction/damage to your U Me, please observe the following:
Do not expose it to moisture or water whilst in operation. It does need to be cleaned with liquids, Me sure to disconnect the USB-C cable and power off the U Me
Do not expose it to heat from any source - it is designed for reliable operation at normal ambient room temperatures
Take care whilst handling to avoid mechanical damage to the unit
Do not tamper with screws or dismantle the product in any way

REGULATORY COMPLIANCE INFORMATION

The YoVo U Me complies with the relevant provisions of the RoHS directive for the European Union, CE/UKCA statements. This product is in conformity with EU directives and UK regulations for Toys, Radio Equipment, RoHS and Electromagnetic Compatibility. WEEE Directive Statement. RoHS Alternative arrangements may apply in the EU or the UK.
not be disposed of in household waste in the EU or the UK.
FCC warning: This device complies with Part 15 of the FCC Rules.
Operation is subject to the following conditions:

1. this device may not cause harmful interference
2. this device must accept any interference received, including interference that may cause undesired operation

RF EXPOSURE INFORMATION

FCC RF Exposure Requirements: the highest SAR value reported under this standard during product certification for use next to the head with a minimum separation distance of 5mm. This transmitter must not be collocated or operating in conjunction with any other antenna or transmitter. This EUT is in compliance with SAR for general population/uncontrolled exposure limits in IC RSS-102 and had been tested in accordance with the measurement methods and procedures specified in IEEE 1528 and IEC 62209. This equipment should be installed and operated with a minimum distance of 5mm between the radiator and your body. This device and its antenna(s) must not be collocated or operating in conjunction with any other antenna or transmitter.

Product Packaging

Product Packaging Design

Lid

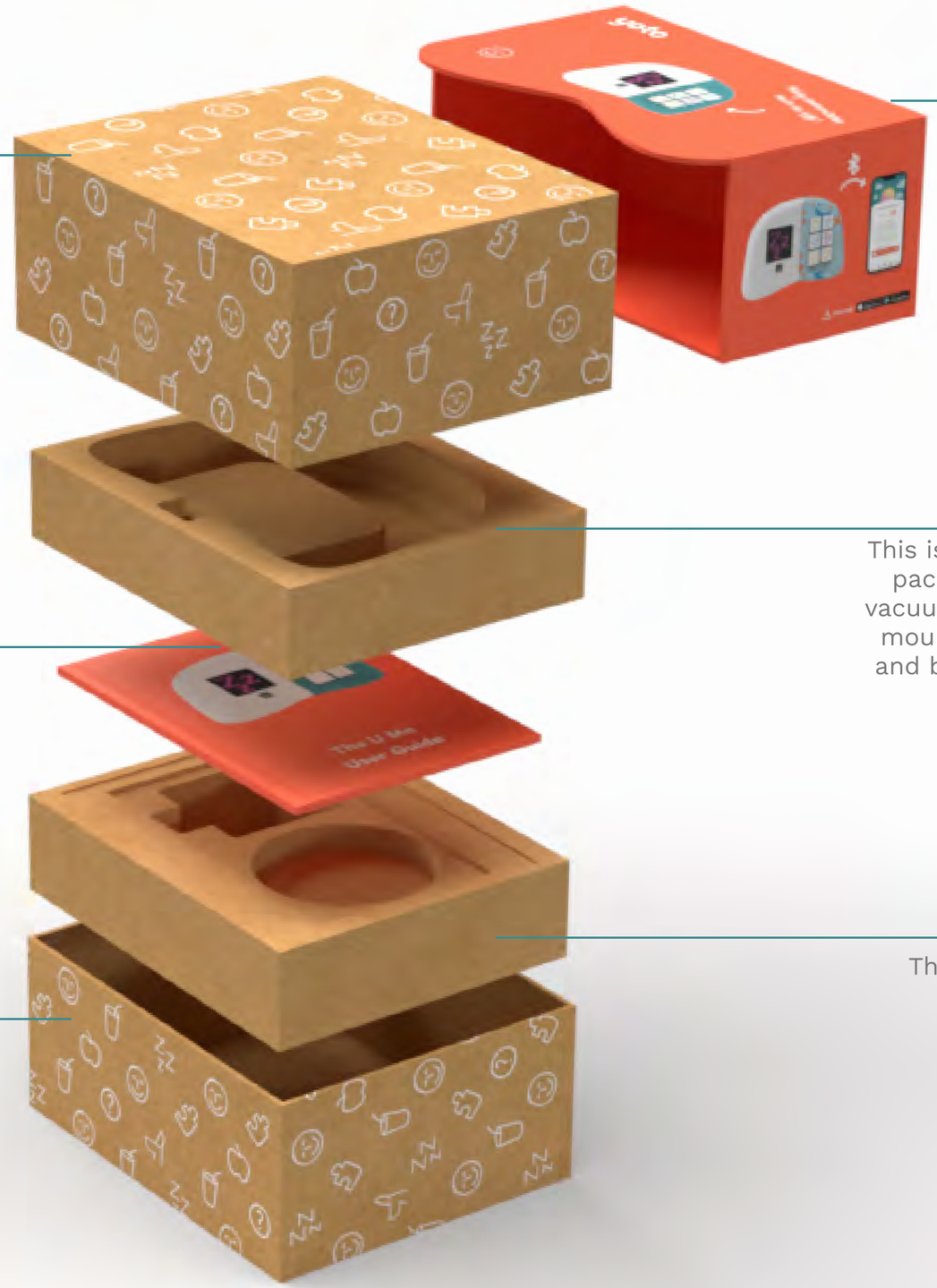
The lid, base and inserts are made from partially recycled cardboard. Recycled cardboard is more malleable, meaning it is easier to make corrugations. A corrugator machine cuts the board to size, which is determined by the FEFCO guide. An FEFCO 0303 box would provide a sleek finish for the U Me packaging. A corrugator separates the boards in to layers and stacks them. A trimmer and bending machine then assembles the box with adhesive.

User Guide

The user and safety guides are made from recycled paper, which is processed by printing, and cutting. The paper can then be recycled again or be thrown away as biodegradable waste. The user guide sits on top of the charger plug and cable.

Base

A lithographic press is used to print the designs and safety information on to the box. Water-based printing ink is used.



Sleeve

An external sleeve is made from 2 mm thick cardboard, with an B-flute corrugation. The graphics are printed onto the box, which is then laminated.

U Me insert

This is where the U Me is stored within the packaging. The insert is manufactured by vacuum forming, wet-pressing, and heating moulded pulp. Moulded pulp is recyclable and biodegradable, so the inserts can also be recycled with the rest of the box.

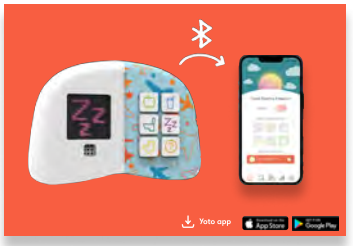
Charger insert

The plug and USB-C cable are stored in the insert beneath the user guide

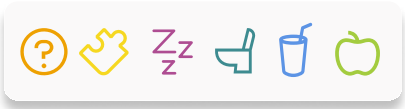
Product Packaging

Yoto Packaging

Implementation



The pattern stems from the button design and yoto logo. This will be printed on the cardboard box



We believe this packaging fits well with the yoto aesthetic. Although children are the users, the packaging ultimately has to appeal to the parents. This is why we made the packaging sleek and modern, as well as unique and playful.

Yoto U Me
£64.99
5060744162027

We have marked up the RRP by just under 50%. This is to take into account additional costs such as shipping, advertising and licence/patents. We also need to have a sufficient profit margin. This price also fits in with yoto's prices.

Final Design

Final Design

Project Plan

09.05
concept selection completed

With the help of a survey conducted by our users, we chose our concept

09.05
brand research and selection completed

Chose Yoto over Mothercare as our parent brand as it has a more coherent design language

30.05
standards, laws and compliance completed

Looked at Yoto's product safety and what was required for children's safety

06.06
form, electronics and app development completed

Changed shape and button arrangement to make ergonomic for children

06.06
physical & digital prototyping completed

FEA analysis led to reinforcing side-walls with ribs. CES EduPack guided materials selection.

13.06
power & load calculations and DFMA completed

Used CAD for DMFA and 3D printed versions of the device to ensure that it fit together. Iterated on reducing the load required by the device

20.06
packaging design & working prototype completed

Designed packaging that fit with Yoto's brand. Overcame issues of LDR not working on prototype by updating a casing design for it

23.06
documentation & video complete

Changed documentation and video to suit Yoto's design language

Amy Walter

Amy was in charge of digital testing (FEA), material selection and development of the final CAD. She was also responsible for DFMA (working closely with Emmeline), technical drawings and accompanying features such as assembly time and cost analysis.

Emmeline Bolton

Throughout the process, Emmeline was in charge of the electronics. She began by prototyping the electronics before developing the final version. She then worked closely with Amy on the working prototype as well as the internal design of the industrial model to ensure that the electronics would fit neatly into it

Eva Brazier

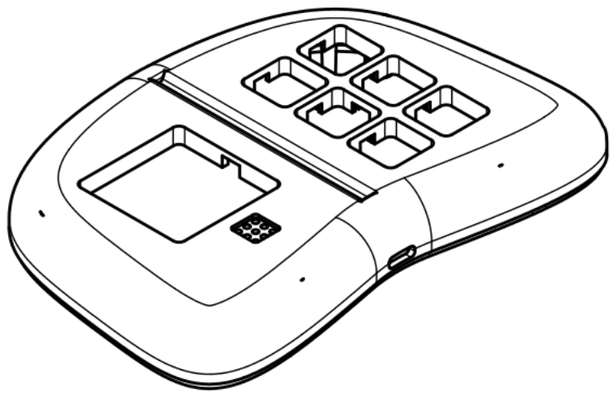
Eva was in charge of much of the creative development. She was responsible for some of the form development of the U Me, as well as designing the jackets that would cover it. She also designed the packaging for the device and rendered the device for the report and video.

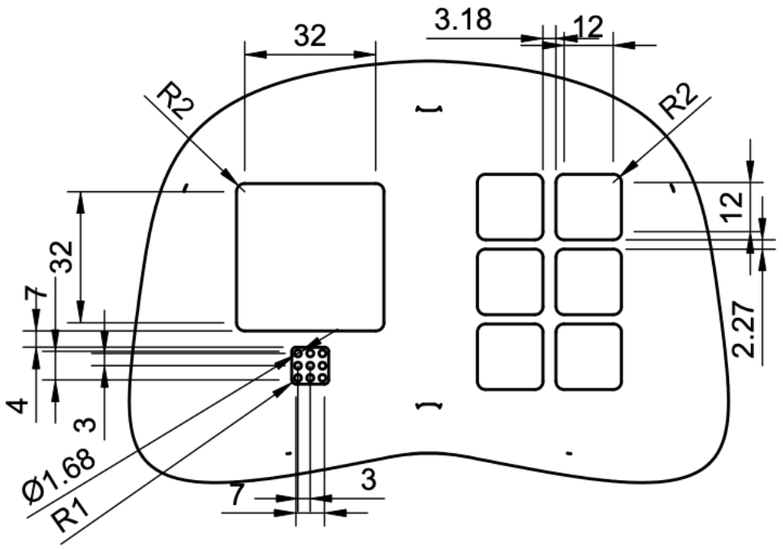
Anusha Narayan

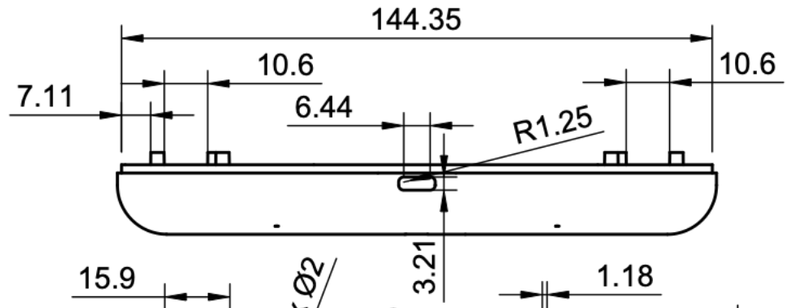
Anusha was in charge of much of the research that was undertaken. For example, she was in charge of branding, as well as product compliance. She developed the U Me app as part of the concept development. She was also responsible for the video.

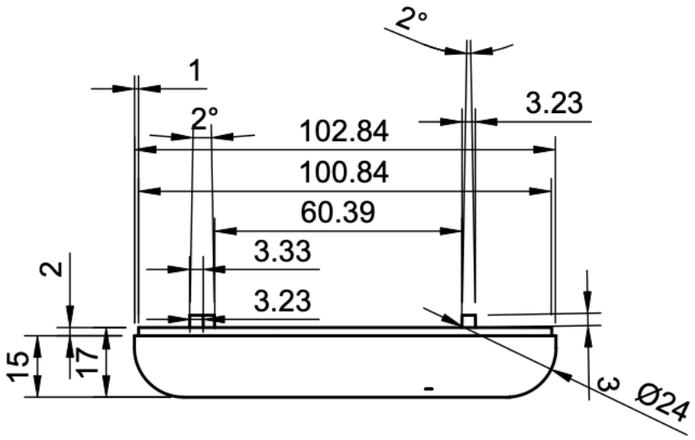
Project Plan

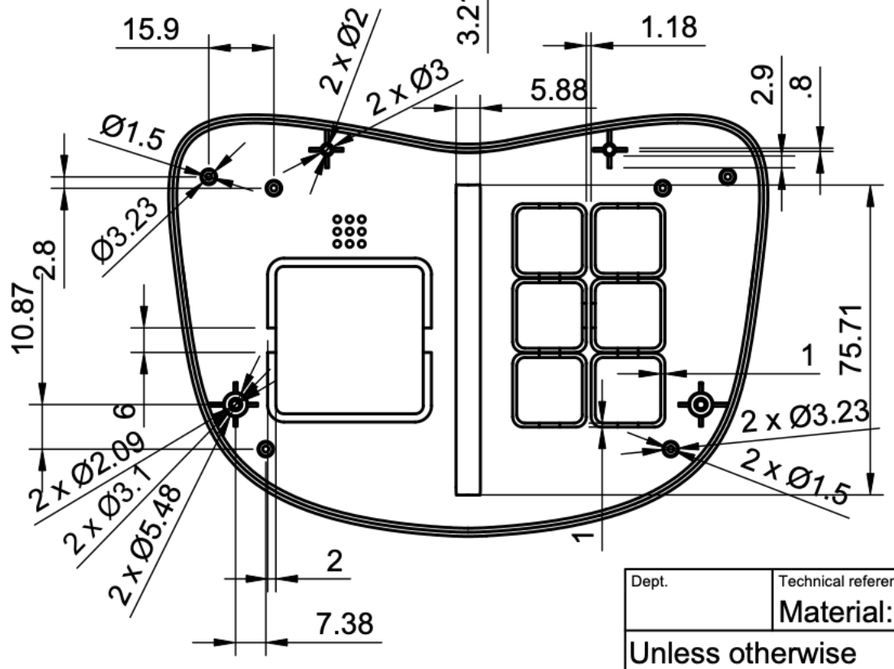
Task	Date	02/05	09/05	16/05	23/05	30/05	06/06	13/06	20/06
branding									
brand research									
brand selection									
concept									
selection									
form development									
electronics									
app development									
laws & standards									
standards									
laws									
labelling									
prototyping									
physical & digital testing									
calculations									
DFMA									
packaging design									
working prototype									
delivery									
documentation									
video & presentation									

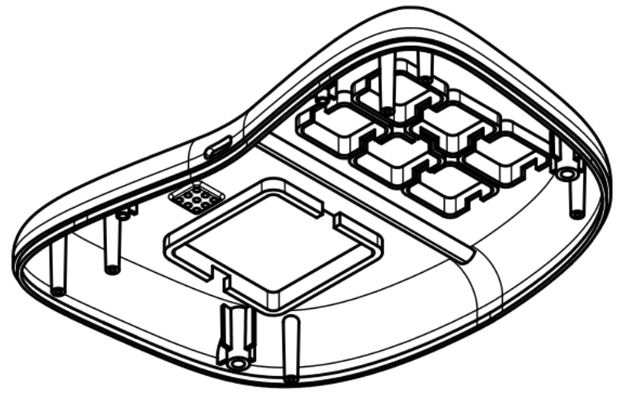




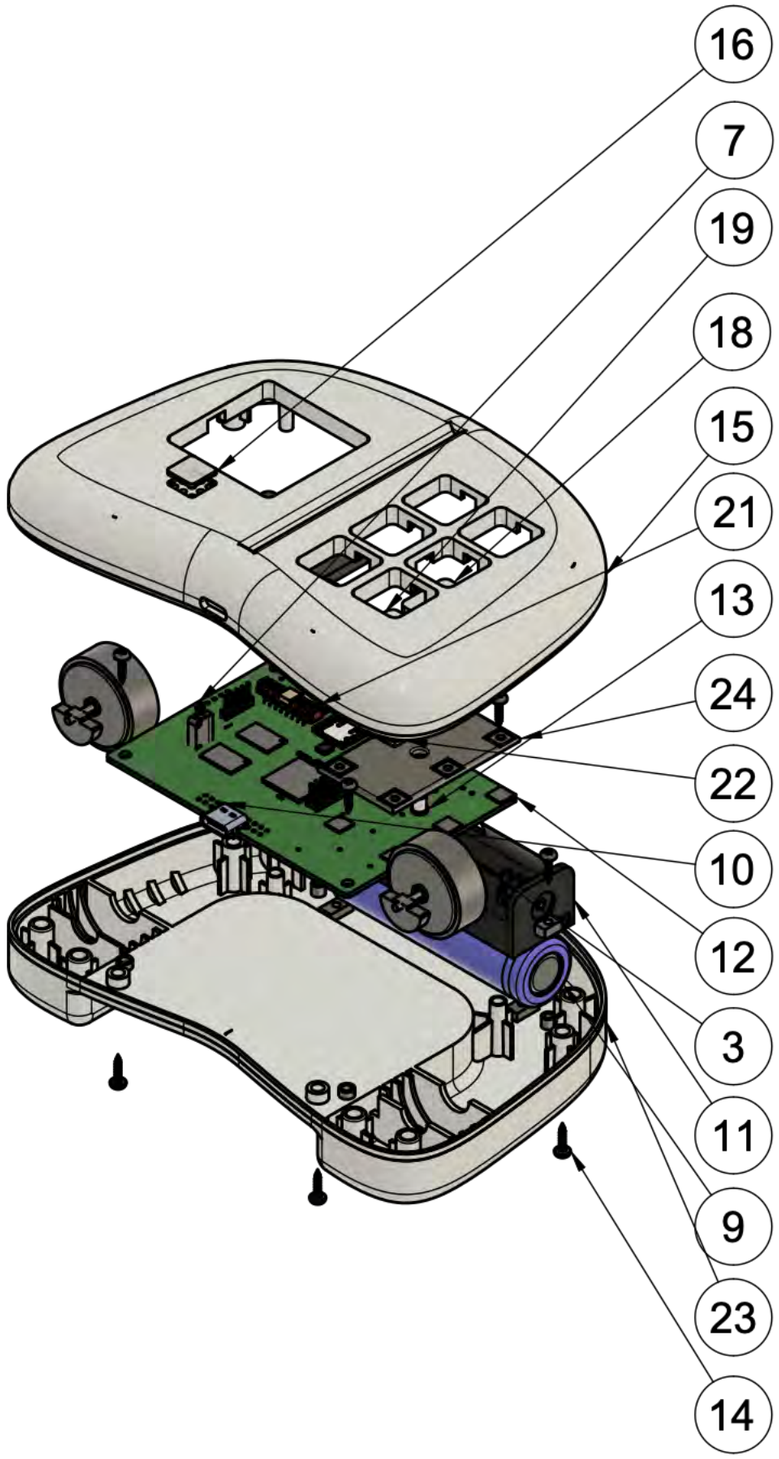






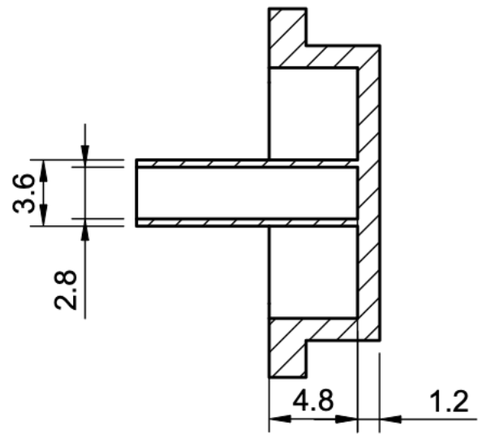


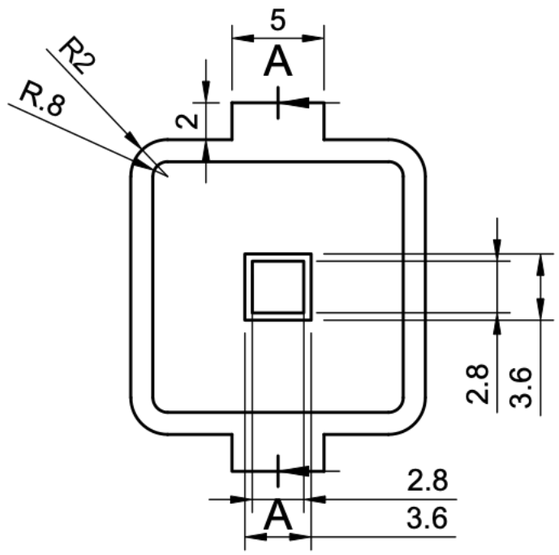
Dept.	Technical reference: Material: ABS	Created by: Amy Walter 20/06/2022	Approved by
Unless otherwise specified: Scale: 1:1.5 Dimensions: millimeters. Surface Finish: SP1 A2. Tolerances: Linear: +/-0.5 Angular: =/-0.5		Document type	Document status
		Title: Upper Shell	DWG No.: 001
			Rev. / Date of issue: 21/06/2022 / Sheet: 1/1

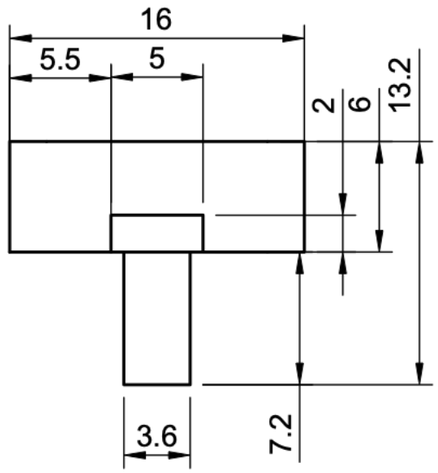


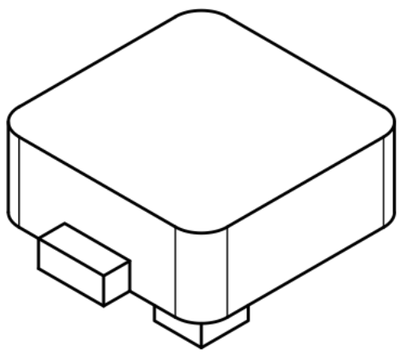
Parts List		
Item	Qty	Part Name
3	2	Vibration Motor v2
7	1	LDR v3
9	1	18650 Li Battery v1
10	1	USB- C Port v1
11	1	Battery Casing v1
12	1	PCB v4
13	1	RGB LED v4
14	10	M3x8 Self Tap Screw v1
15	1	Upper Casing
16	1	LDR Casing
17	1	Button 1
18	1	Button 2
19	1	Button 3
20	1	Button 4
21	1	Button 5
22	1	Button 6
23	1	Lower Casing
24	1	Button Contacts

Dept.	Technical reference Scale: 1:1.5	Created by Amy Walter 21/06/2022	Approved by
		Document type	Document status
		Title Bill of Materials	DWG No. 004
			Rev. / Date of issue 21/06/2022 / Sheet 1/1

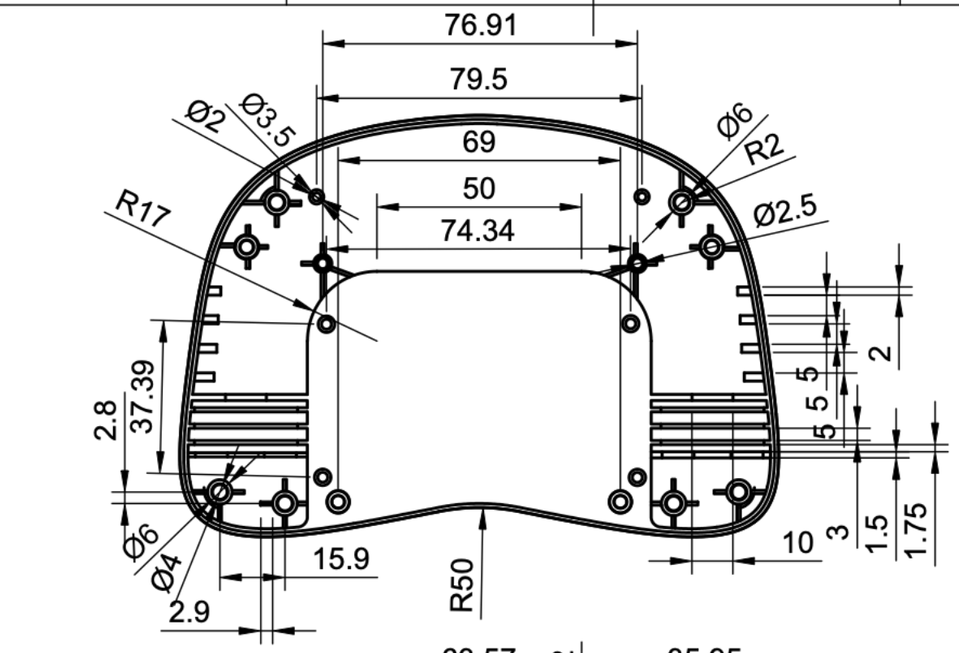


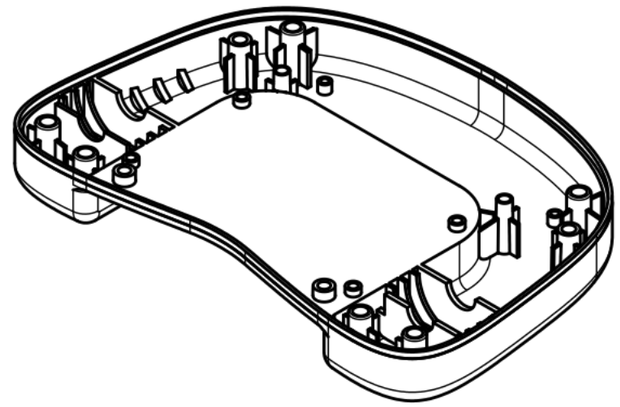


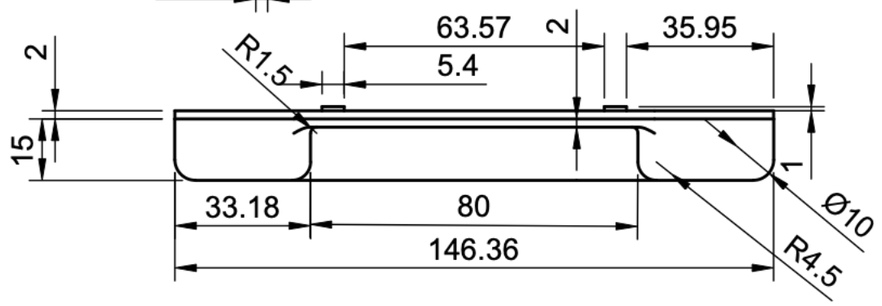


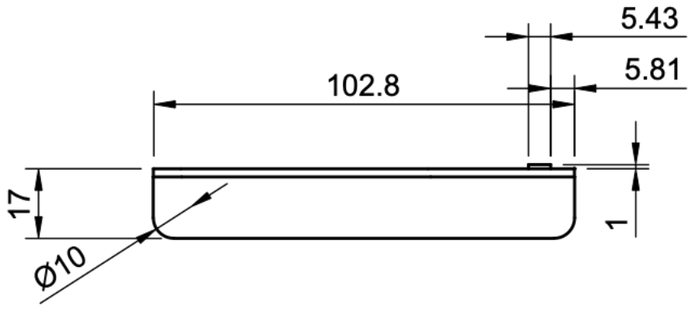


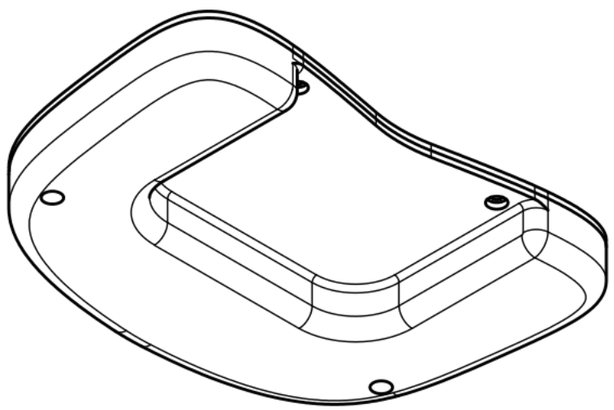
Dept.	Technical reference: Material: ABS	Created by: Amy Walter 21/06/2022	Approved by
Unless otherwise specified: Scale: 3:1 Dimensions: millimeters. Surface Finish: SP1 A2. Tolerances: Linear: +/-0.5 Angular: =/-0.5	Document type	Document status	
	Title: Buttons x 6	DWG No.: 003	
		Rev.	Date of issue: 21/06/2022 / Sheet: 1/1

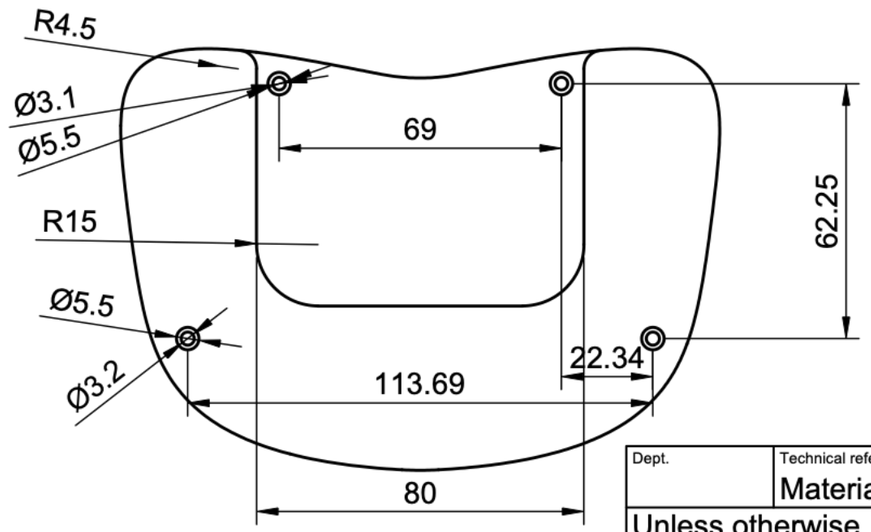












Dept.	Technical reference: Material: ABS	Created by: Amy Walter 21/06/2022	Approved by
Unless otherwise specified: Scale: 1:1.5 Dimensions: millimeters. Surface Finish: SP1 A2. Tolerances: Linear: +/-0.5 Angular: =/-0.5	Document type	Document status	
	Title: Lower Shell	DWG No.: 002	
		Rev.	Date of issue: 21/06/2022 / Sheet: 1/1

References

[1] *Yoto- The Screen-Free Audio Player for Children*. Available at: <https://uk.yotoplay.com/> [Accessed 23 June 2022].

[2] *Our vision and strategy.* Mothercare. Available at: <https://www.mothercareplc.com/who-we-are/our-vision-and-strategy.aspx> [Accessed 23 June 2022].

[3] *Our mission, vision and values.* National Autistic Society. Available at: <https://www.autism.org.uk/what-we-do/who-we-are/our-mission-vision-and-values> [Accessed 23 June 2022].

[4] Google Images. Available at: <https://images.google.com/> [Accessed 23 June 2022].

[5] CES Edupack software 2022.

[6] *Xbox 360 Wireless Controller Teardown*. iFixit. Available at: <https://www.ifixit.com/Teardown/Xbox+360+Wireless+Controller+Teardown/123908> [Accessed 23 June 2022].

[7] *Battery Casing.* Available at: <https://www.digikey.co.uk/en/products/detail/mpd-memory-protection-devices/BK-18650-PC2/2079908> [Accessed 23 June 2022].

[8] *Right Angle, SMT, Socket Type Type C 2.0 USB C Connector* | RS Components. Available at: <https://uk.rs-online.com/web/p/usb-connectors/2153153> [Accessed 23 June 2022].

[9] *Adafruit DotStar High Density 8x8 Grid - 64 RGB LED Pixel Matrix*. Available at: <https://thepihut.com/products/adafruit-dotstar-high-density-8x8-grid-64-rgb-led-pixel-matrix-ada3444variant=12364068192318&currency=GBP&utm_medium=product_sync&utm_source=google&utm_content=sag_organic&utm_campaign=sag_organic&gclid=CjwKCAjwtcCVBhA0EiwAT1fY70Q38ut7uYRQ4JkNcL8dXDsnkIWri59wC1sOzv7Trma8AEJMC8cLnRoC7GQQAvD_BwE> [Accessed 23 June 2022].

[10] *Motor Rumble - Consumer Electronics* - AliExpress. Available at: <https://www.aliexpress.com/w/wholesale-motor-rumble.html> [Accessed 23 June 2022].

[11] *10 Boss Design Guidelines one should follow in Plastic Parts Design* | DFMPro Blog. Available at: <https://dfmpro.com/blog/10-simple-design-guidelines-one-follow-effective-design-boss-features-plastic-parts/> [Accessed 23 June 2022].

[12] *Power NANO 33 BLE sense with 3.3V.* Available at: <https://forum.Arduino.cc/t/power-nano-33-ble-sense-with-3-3v/654217/5> [Accessed 23 June 2022].

[13] MIT App Inventor. Available at: <http://appinventor.mit.edu> [Accessed 23 June 2022].

[14] *Using the UKCA marking*. Available at: <https://www.gov.uk/guidance/using-the-ukca-marking> [Accessed 23 June 2022].

[15] *Internal Market, Industry, Entrepreneurship and SMEs.* CE marking. [online] Available at: <https://ec.europa.eu/growth/single-market/ce-marking_en> [Accessed 23 June 2022].

[16] *BSI Kitemark for product testing* - UK product and service quality certification mark. Available at: <https://www.bsigroup.com/en-GB/kitemark/product-testing/> [Accessed 23 June 2022].

[17] *Yoto – Product safety.* Available at: <https://uk.yotoplay.com/pages/conformity> [Accessed 23 June 2022].

[18] *BS EN 71 - Safety of toys*. Available at: <https://landingpage.bsigroup.com/LandingPage/Series?UPI=BS%20EN%2071> [Accessed 23 June 2022].

[19] *The General Product Safety Regulations 2005*. Available at: <https://www.legislation.gov.uk/uksi/2005/1803/contents/made> [Accessed 23 June 2022].

[20] *Toys (Safety) Regulations 2011: Great Britain.* Available at: <https://www.gov.uk/government/publications/toys-safety-regulations-2011/toys-safety-regulations-2011-great-britain#:~:text=The%202011%20Regulations%20set%20out,the%20'essential%20safety%20requirements'.> [Accessed 23 June 2022].

[21] *What is Restriction of Hazardous Substances Directive.* Available at: <https://www.techtarget.com/searchdatacenter/definition/Restriction-of-Hazardous-Substances-Directive#:~:text=The%20Restriction%20of%20Hazardous%20Substances,is%20effective%20July%201%2C%202006.> [Accessed 23 June 2022].

[22] *The Ecodesign for Energy-Related Products Regulations 2010.* [online] Available at: <https://www.legislation.gov.uk/uksi/2010/2617/contents/made> [Accessed 23 June 2022].

[23] *Download Free Stock Photos, Images and Backgrounds.* Vecteezy. Available at: <https://www.vecteezy.com/free-photos> [Accessed 23 June 2022].

Video Link: https://youtu.be/Hsf9Sks_270