Project Summary

MEng Product Design Engineering
2020

> *"EasyShave: a wearable wristband paired with an app that facilitates independent shaving in men with Down's syndrome"*
>
> *Alex Duff*

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The Problem

Area of focus

There are around 22,000 males living in the UK with Down's syndrome. Roughly 60% of these cannot shave independently. This is due to having to be guided through the process by a family member/ carer, who must also be there to ensure that the shave has been completed properly. Facial grooming is an important part of a man's visual identity, with an entire industry being built around it in the past hundred years or so. It is important that those with Down's syndrome are not left behind

25 → 60

(1980) *(2020)*

The life expectancy of an individual with Down's syndrome has increased dramatically over the past 40 years. This can be attributed to advances in medical care and a societal shift in attitudes towards disabilities in general

> ***"Many people with the disability will now outlive their parents...who is going to care for them? The time for facilitating independence is now!"***
>
> *Social worker*

Insights & PDS

Stakeholder engagement

The project brief and user requirements were shaped through a combination of desk research and engagement with key stakeholders. These included people with the disability, their childminders, carers and familiy members, alongisde occupational therapists, social workers, teachers in schools for people with learning difficulties and an expert within the NHS for using assistive technology to help with independence

Key insights

- *Video games are a great way to learn new skills*
- *Many users struggle with daily tasks like shaving, but can concentrate intently on video games*
- *Imitation and copying are a great way of teaching new skills*
- *A lot of people with learning difficulties are extremely good with technology*
- *Facial shaving is a mundane, daily task that takes up family member/carer's time*
- *Nearly 90% of my user group had access to an iPad - in some instances supplied by the government to facilitate independence and help teach new skills*
- *Electric shavers were used rather than razors, for ease of use and safety reasons*

> ***"We need to sit him down every evening and guide him through the shaving process...it's exhausting and very time-consuming"***
>
> *Dad of young man with Down's syndrome*

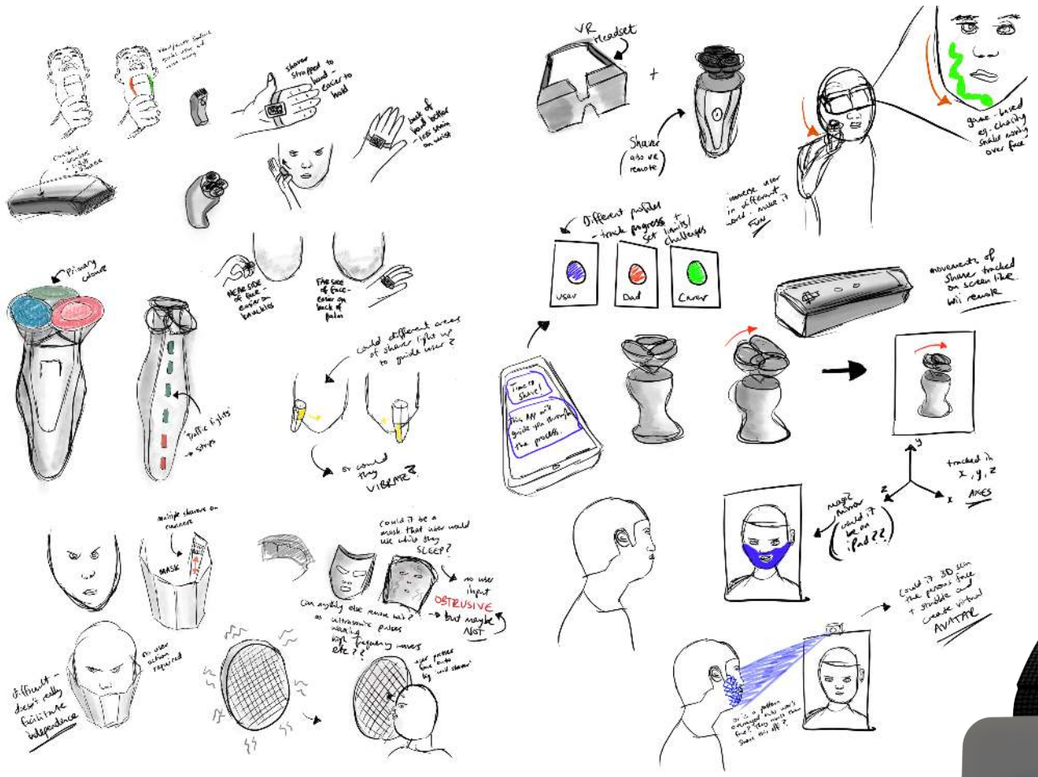
Product requirements

Monitor user while shaving	*Guide user through the process*	*Verify that shave is complete*	*Be a fun/ interactive experience*	*Communicate with user's family/carers for peace of mind*	*Be easy to use/ intuitive*	*Could utilise available iPad technology*

The Solution

From first concept to final product

From the initiation of the brief, months of research, concept generation, prototyping and refining led the project from sketches and ideas right through to a fully refined solution



Introducing 'EasyShave'

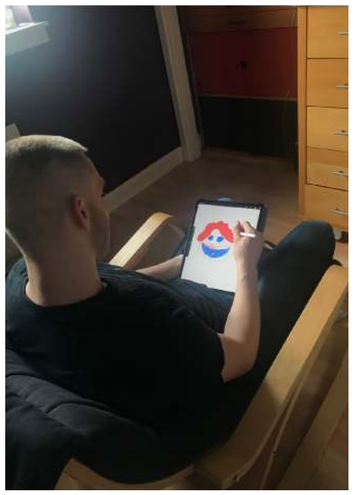
EasyShave is an app that facilitates independent shaving in men with Down's Syndrome. Using augmented reality (AR) technology, the app would overlay a visual pattern over the user's face that they must remove with the electric shaver (while simultaneously removing their facial hair). The AR guides the user through the shaving process in an easy to follow way, using visual prompts and instructions for user to imitate. A wearable wristband containing a microphone module is worn during the shave

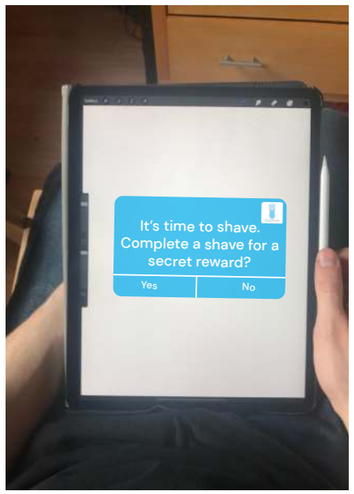
When the shaver is pressed onto the face and begins cutting hair there is a spike in amplitude of sound wave, occuring at a specific frequency. When this specific sound pattern is detected by the microphone, the app knows that user is shaving so removes the visual pattern precisely and accurately. It then uses the iPad camera to verify that the shave has been completed and sends a notification to user's carer/family member to let them know

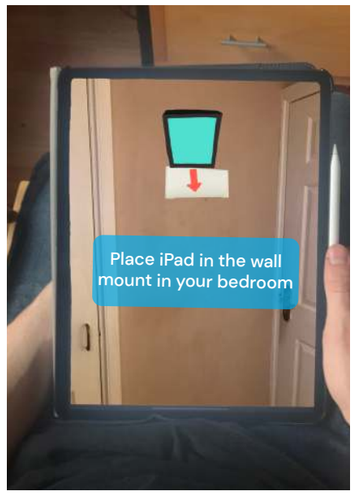
User Journey

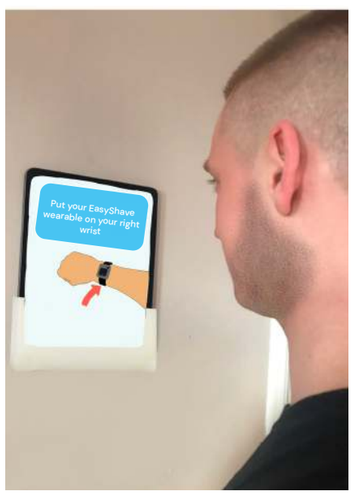
User unshaven for 3 days. Notification prompts to begin shaving process. User can choose whether they want to shave or not

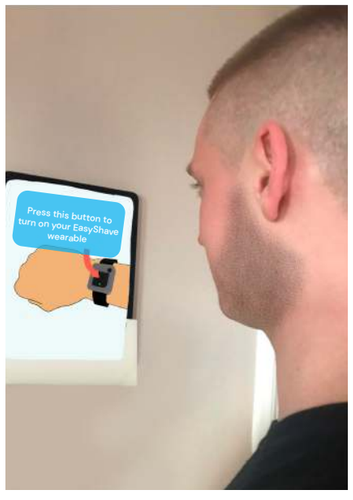
App guides user through setup using a series of visual instructions, including where to mount iPad and turning on wearable

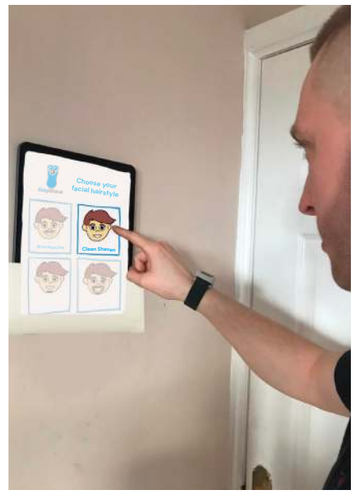


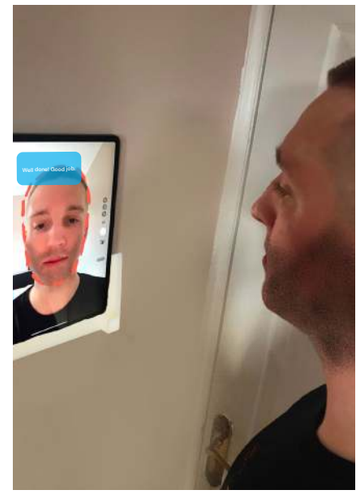












Elastic strap allows wearable to easily be slipped on. No difficult buckles or clasps - designed for people with poor fine motor skills in mind

Visual, easy to follow instructions on turning ON wearable and shaver

Choose facial hair style - putting users in charge of their appearance. If user chooses 'tash' then there is no visual pattern overlayed over that area

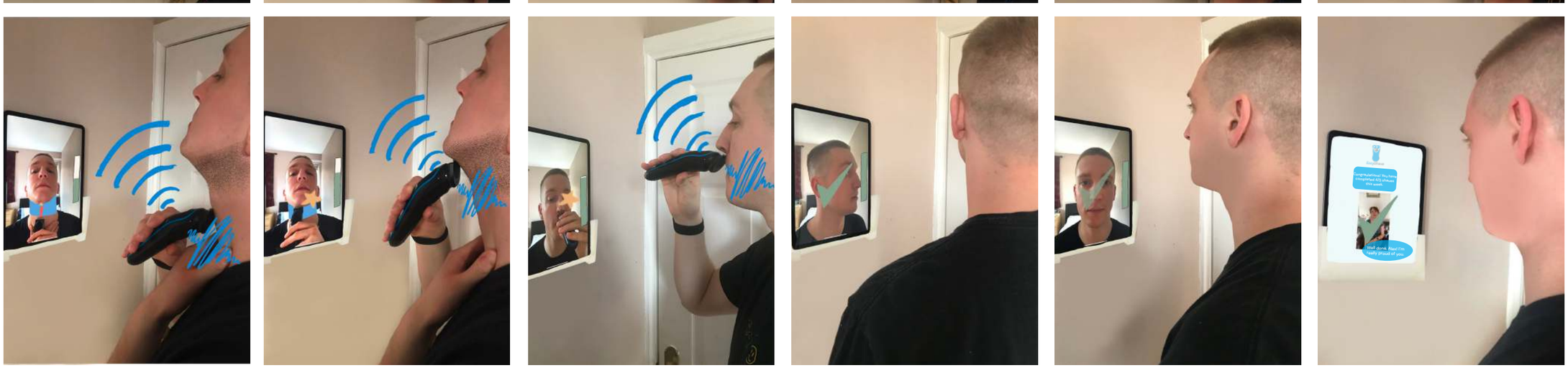
Calibration ensures user in optimum position for camera. If user steps too far out of this zone they are simply asked to recalibrate

User Journey

Bright, visual pattern overlayed onto user's face on screen, along with augmented reality instructions guiding user through shaving process that they imitate

User performs stroke picked up by camera but doesn't touch face with shaver - 'sound' of shaving not picked up by wearable mic - pattern not removed

*This time user performs stroke and shaver makes contact with face - 'sound' of shaving picked up by wearable mic and visual pattern removed**



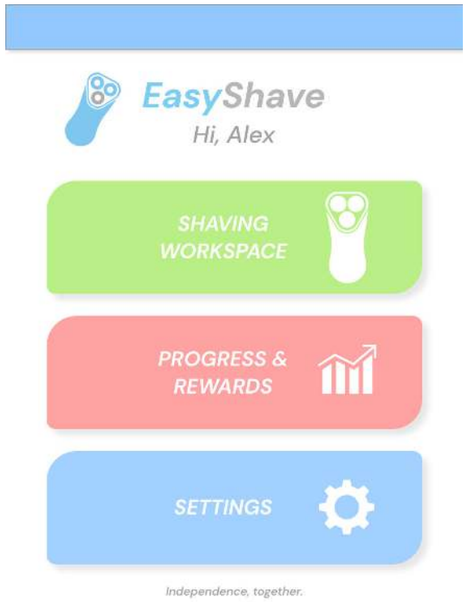
The AR guides user through the process, and a progress bar builds up at the side - completing the shave completes the game and user gets a reward (e.g. iTunes voucher) redeemed via the app

AR asks user asked to show face from all angles. TrueDepth iPad cameras able to detect miniscule differences in facial hair - shave verified. Notification sent to family member/carer which gives them peace of mind

**Further details on the engineering behind this concept found on the 'Proof of Concept' page*

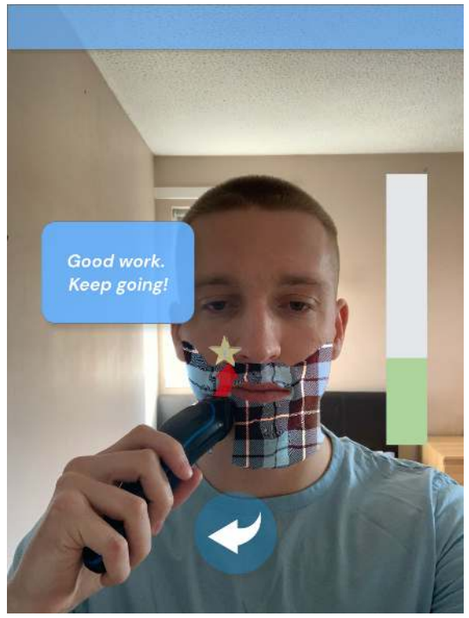
The EasyShave App

Home Page

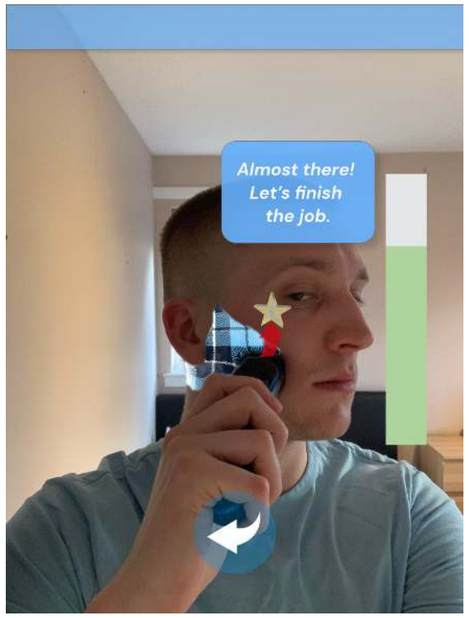


Links to all of the app's functional features. Primary colours allow user to associate colours with different aspects of the app. Simple to use, very visual and not too much clutter

'Shaving Workspace'



Brought into the shaving workspace. Can go back at any time (e.g. to adjust gamification levels/ contact family member etc). Progress bar builds up as users collect custom EasyShave gold stars



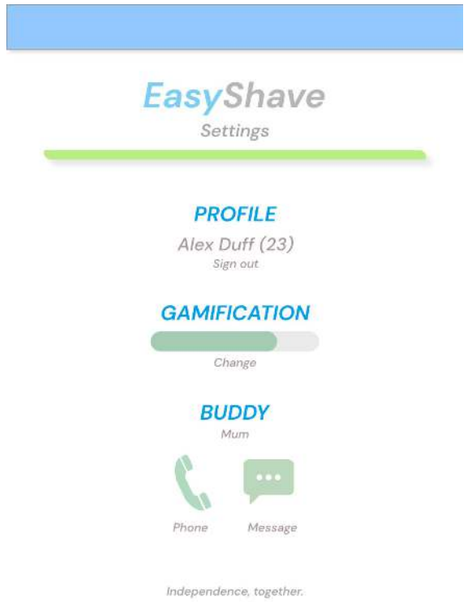
Visual pattern can be adjusted in settings in the gamification section. User can choose colour, style etc. Can also change the type of game - could be mystery boxes to collect like Mario Kart, or visual pattern could be changed to grass and shaver would appear as a lawn-mower and user has to 'mow the grass' - endless opportunities and these could be updated regularly i.e. new games released every month. Updates would maintain interest in the game over time

Progress & Rewards

Users can see at a glance short term goals, and click 'see more' to see progress over time

Their rewards show up here too, which they can redeem - e.g. voucher for Starbucks with a friend, or iTunes voucher to rent a movie

Settings

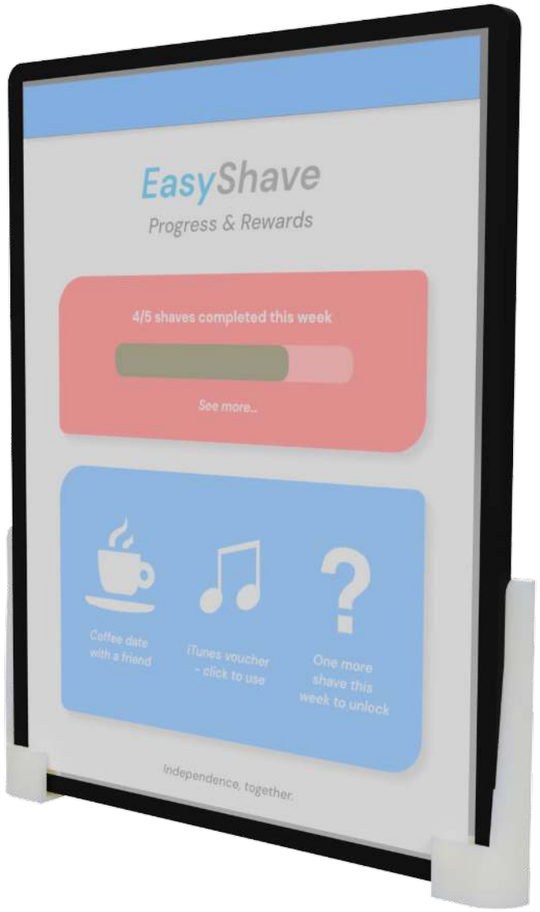


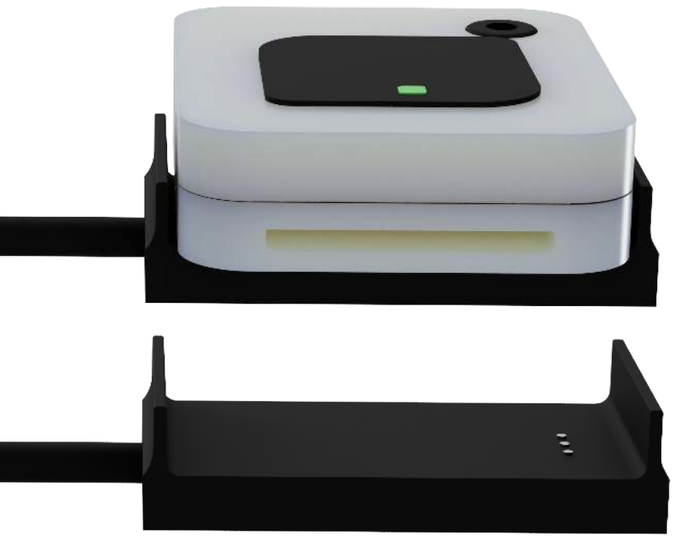
Again not too much clutter. Can add/edit profiles (if more than 1 person using app). Can adjust the gamification levels. Reducing gamification over time means user learns independent shaving at their own pace. 'Buddy' selected at app setup - family member or carer. Notifications automatically sent to user's buddy - 'shave complete' or 'user has missed today's shave, want to message them?'

Product Details

iPad mount included

These are standard parts and would be included in the 'final packaged' product. Adhesive strips allow iPad to be mounted on any surface without the need for glues or screws. The mount stays on the wall and the user simply places iPad in before shaving





User-friendly charging dock

Male electrical charging pins on the base of the dock clip securely into female pins on the back of the wearable, making the charging process as easy as possible for the user. The app will remind user to charge after use

Subtle product branding

Subtle logo imprinted onto the back face keeps a clean aesthetic and ensures that only the button and microhpone are visible from the uesr's perspective when in use. As with the app, simplicity is key

Proof of Concept

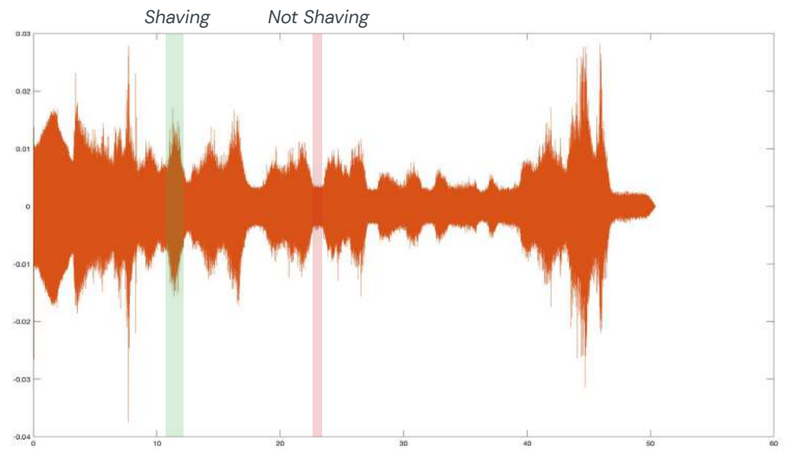
Comprehensive audio testing undertaken

Rigorous testing ensured that the engineering behind the concept was solid; involving recording and analysing the audio signals generated in a number of different common shaving scenarios in Matlab. The 'sounds' of shaving and not shaving can be separated even when user speaks during the shave, or if they are watching a TV show in the background. This testing also highlighted the need for a physical wearable, as the microphone had to be as close as possible to the sound waves generated for optimal signal capture

Sound wave analysis

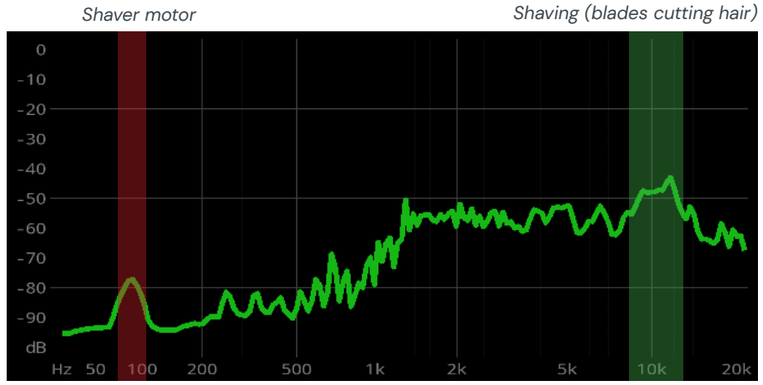
Audio files recorded while shaving analysed in both the time domain (voltage vs time) and frequency domain (amplitude vs frequency) in Matlab and FrequenSee software. This data would be captured in real time by the microphone and processed by a field-programmable gate array (FGPA) chip which would tell app when user shaving/not shaving

Time domain



**Each 'spike' in the graph corresponds to a shaving stroke*

Frequency domain



....& everything in between

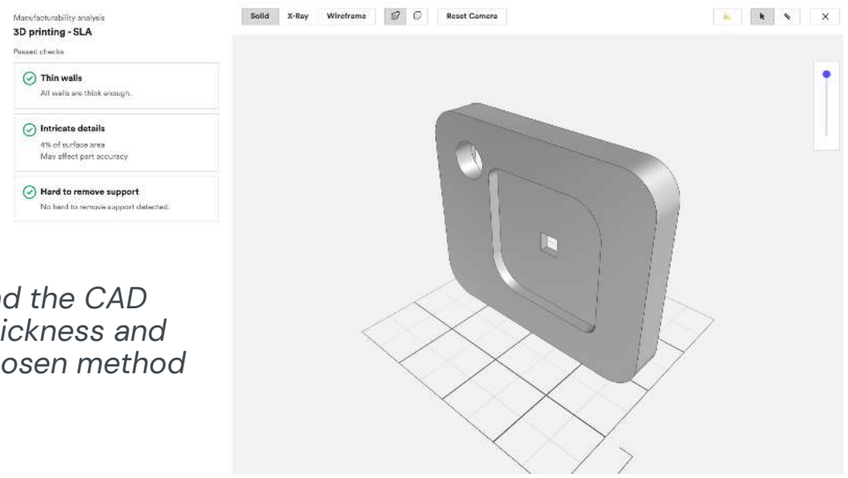
Materials & Manufacturing

3D printed wearable

Front and back faces 3D printed from pro grey resin using the stereolithography (SLA) method. Liquid resin is pulled up out of a resin bath and solidified by a laser, creating 3D shape layer by layer. This results in highly precise parts with a smooth surface finish and tolerances as low as +/- 0.15mm

Printability analysis

*Undertaken virtually through **3DHubs** and the CAD models altered to ensure correct wall thickness and geometries for optimal printing using chosen method*



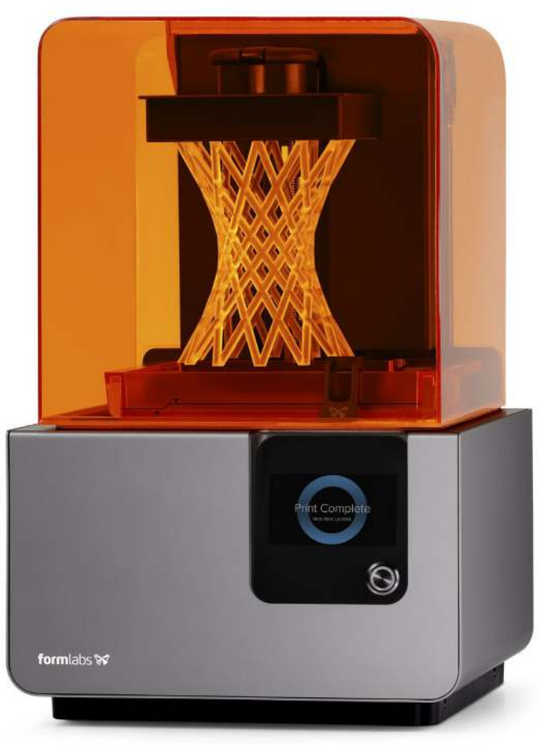
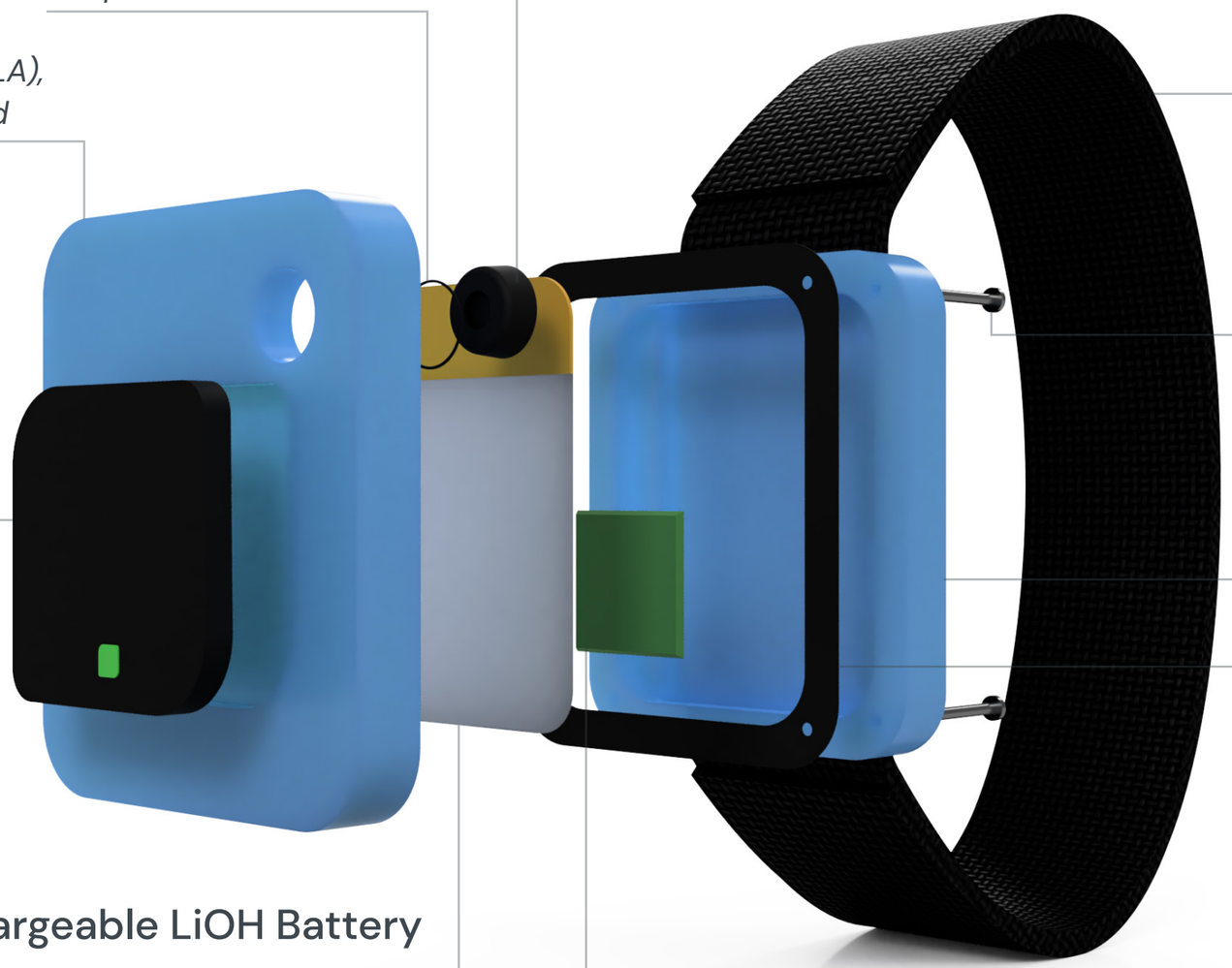


*Image by **3DForged** on **Pinterest***

Different colour choices

After printing, the 3D parts are primed and spray-painted. This allows users to personalise their wearable, forming a personal attachment and encouraging compliance with the product

Materials & Manufacturing



Front Face
Pro Grey Resin - 3D Printed (SLA), then primed and spray-painted

Microphone Seal
Neoprene - Custom Made

Waterproof Microphone Module
Standard Part

Elastic Band
24mm Width Sewing Elastic - Cut to Size & Sewn

4xM1 7mm Screws
Standard Parts

Tactile Button with LED
Standard Part

Back Face
Pro Grey Resin - 3D Printed (SLA), then primed and spray-painted

170mAh Rechargeable LiOH Battery
Standard Part

Body Seal
Neoprene - Custom Made

FGPA Processing Chip
Outsourced Custom Part - Containing Bluetooth Chip, Accelerometer, Gyroscope & MCU