tacta

10 page summary

Andrew Crook

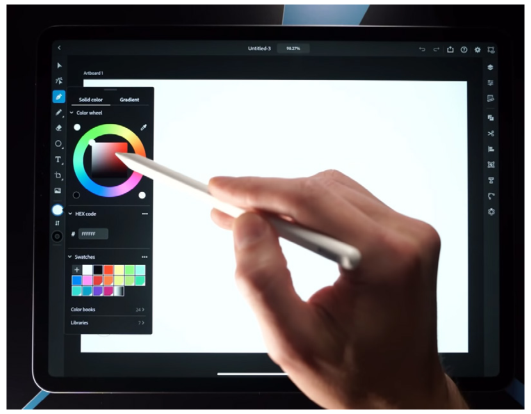
University of Glasgow

THE GLASGOW SCHOOL OF ART

Initial Research

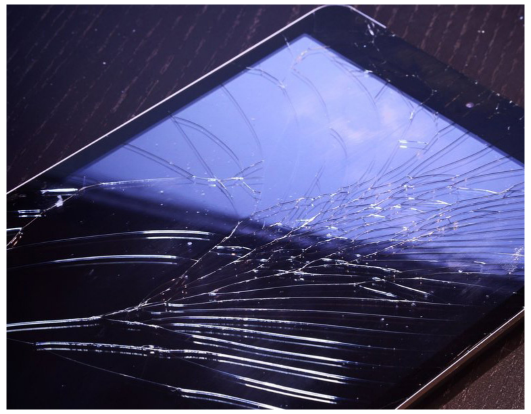
The Problem

Touch screen input can only use on-screen buttons, or functions that have gestures assigned. Within detailed apps this results in either the screen being cluttered with functions or hiding these behind layers of menus.



Within tablets there is no access to keyboard shortcuts, which have been found to be more efficient and faster to use than icon tool bars and menus. Both common elements within touch interface design.

Through user interviews it is clear that while tablets are used in a range of locations, some tablet users have fears of using their tablets in the intended portable way in case the expensive and easily broken device is dropped.



The User

Designers of all varieties and abilities were selected as individuals who typically use software that benefits from keyboard shortcut use. The natural input that tablets are able to provide through the use of a tablet pen benefit the creativity of a designer, leading to high use of both within this field.

The Solution

A product that provides productivity benefits to designers working on tablets through increased accessibility of keyboard shortcuts. It should be able to do this while working wherever they choose to, at a desk or with the tablet in hand, providing a secure and trustworthy grip on the device, leaving the dominant hand free to operate the tablet with the hand or a tablet pen.

The Demand

There is a large market of products that can proide keyboard shortcuts aimed at designers. Existing solutions have one common limitation; they are only usable at a desk if a tablet pen is required in the dominant hand. This goes against the portable nature of tablet computers.

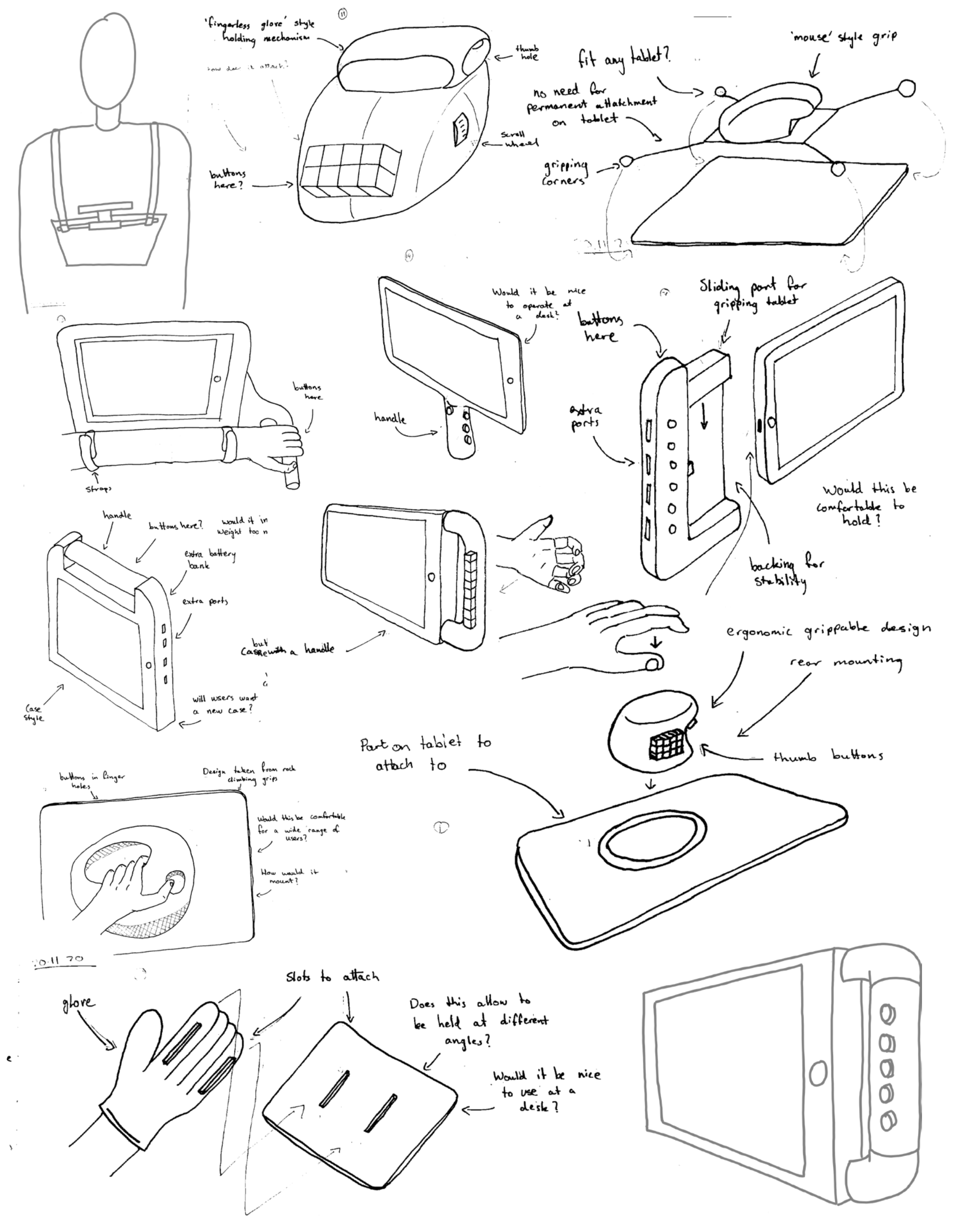
Tablets are being sold to replace traditional computing devices, but discussions with users highlighted that currently they are not a capable replacement for many uses as more is needed to be done to bridge the gap in

An increasing number of complex apps are being converted to work on tablets, or purpose-built for mobile operating systems. These styles of programs historically benefit from and are filled with keyboard shortcut commands.

Concept Development

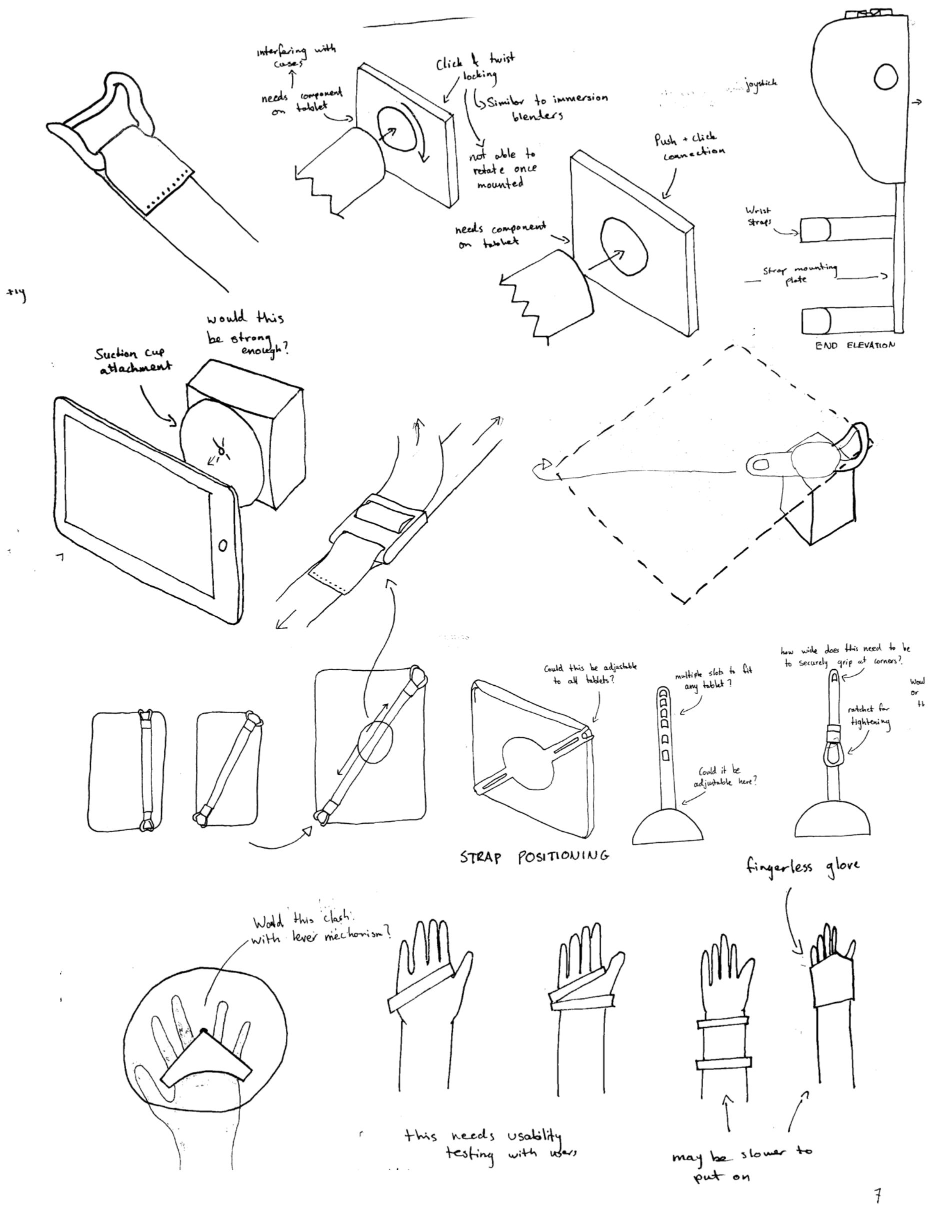
Range of Concepts

Generating a concept that provided a secure holding solution took initial development down three main avenues. These consisted of wearables, interactive cases and attachable products in various forms. A rear-mounted product was selected due to the possibility to design a product within this style that is equally ergonomic to use next to the tablet at a desk and while mounted. If designed to fix to any tablet, the environmental implications of designing a case for a specific model that may become obsolete in a few years can be avoided.



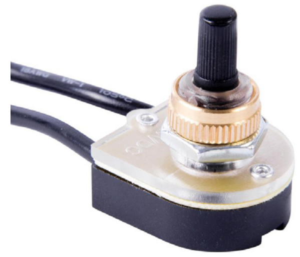
Refinement

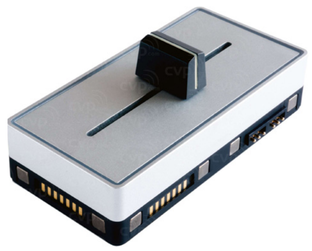
The design has been refined through identification of possible mounting systems and ways of attaching to the user's hand. A suction cup was determined as the ideal design as it allows the product to be attached to and detached from a range of surfaces in a quick and easy processes. Securing the product to the hand was chosen to be done through a single strap across the back of the hand passing between the fingers and thumb, minimising strain on the hand and maximising possible movement within fingers for controlling inputs.



Function Inclusion

Many input methods have been considered but only buttons have been included to avoid featuring components that are obsolete within most apps, whose developers have not designed with their use in mind.


Aesthetic Requirements

Within the existing market for tablets, tablet peripherals and keyboard shortcut products, there is a clear common theme of minimal designs lacking in colour and featuring matte finishes. For the product to be successful within these markets, it shall fit within this existing design ethos. This is crucial to ensure users want to attach the device to their luxury tablets.



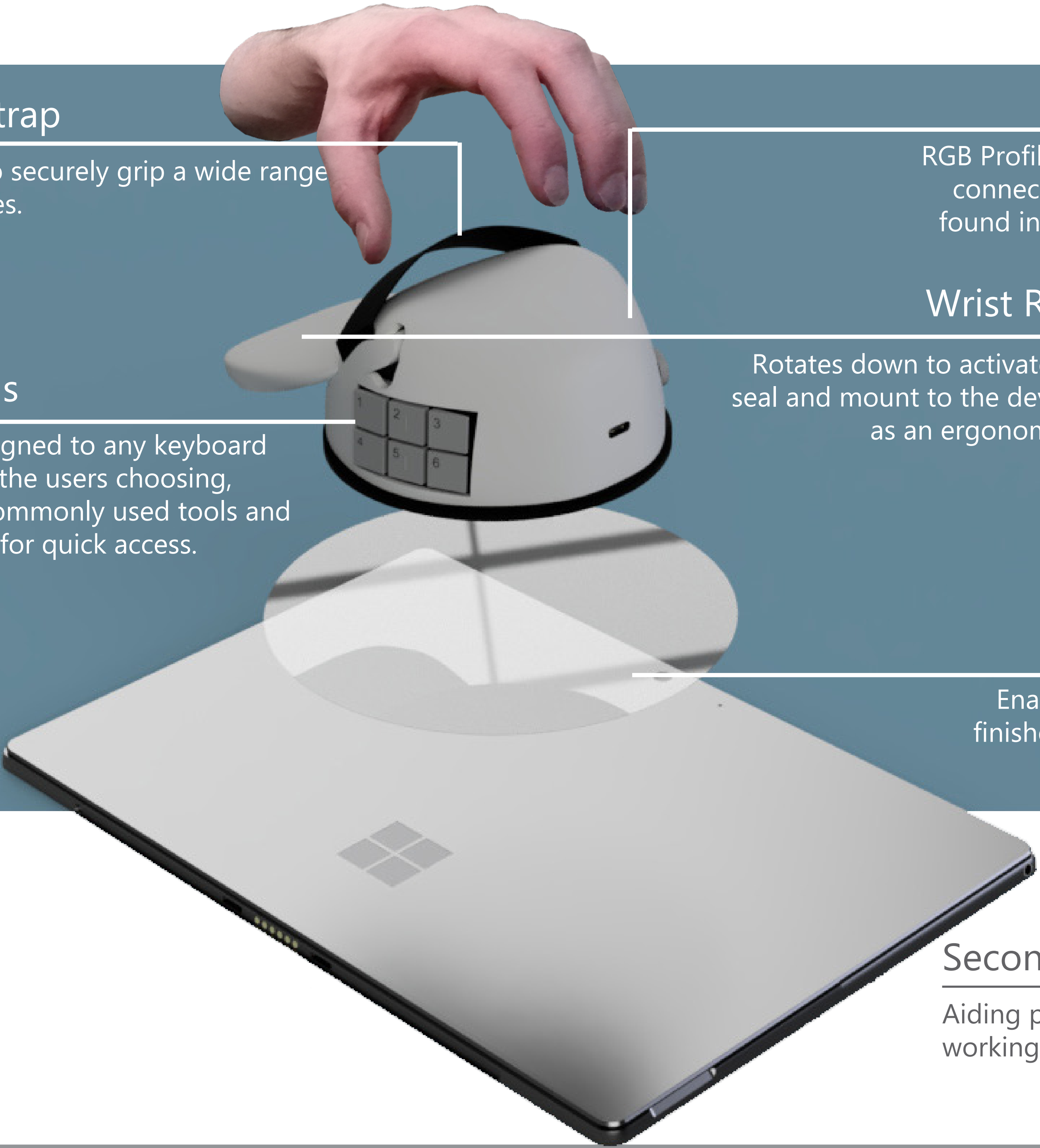

General Overview

tacta provides the keyboard shortcut solution to tablets that users did not realise they were waiting for. Discussions with users highlighted that their fears of dropping their tablets prohibited their use as the truly portable devices they are. A lever activated suction cup will eliminate these through its robust, functional design. Allowing the musculoskeletal advantages of working in a range of environments to be exploited and removing the worker from the desk. To ensure users are able to work on their tablet as they intend, the device is able to rotate to any angle when attached, an important feature discovered through watching users create on their tablets.

Shortcuts, Macros and Profiles

Each button may be assigned a shortcut or macro by the user. A macro is a program which combines multiple tasks into one, useful to simplify complicated workflows consisting of multiple commands used successively.

A profile is the standard name given to a collection of macros, when the profile button is pressed the next profile within the sequence is activated, the button's function and LED colour change accordingly. This allows for a set of shortcuts to be saved, for a range of programs and switched between on the fly.



Elastic Strap

Stretches to securely grip a wide range of hand sizes.

Extra Functions

RGB Profile indicating LED, power, Bluetooth connectivity and profile switching buttons found in mirror location to thumb controls.

Wrist Rest Lever

Rotates down to activate the suction seal and mount to the device, doubles as an ergonomic wrist rest.

6 Buttons

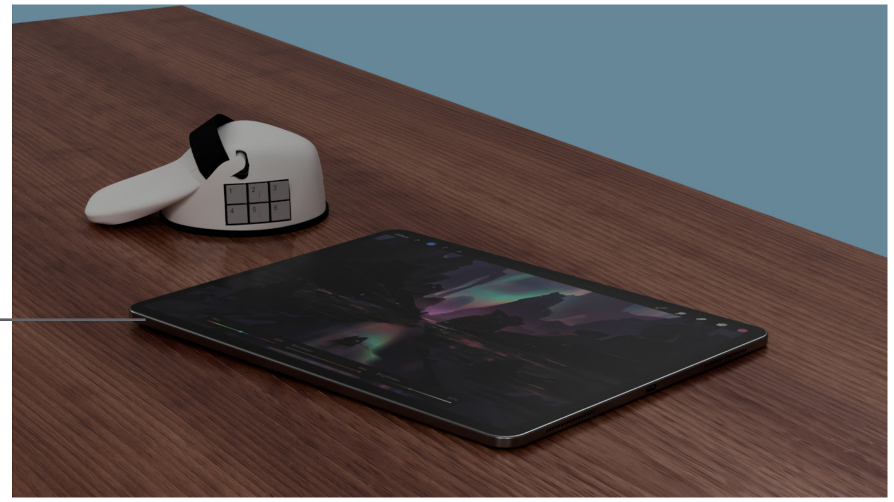
May be assigned to any keyboard shortcut of the users choosing, generally commonly used tools and commands for quick access.

Mounting Sticker

Enables fixing to cases, porous surface finishes and scratched/engraved tablets.

Second Use Mode

Aiding productivity in the hand or when working at a desk.

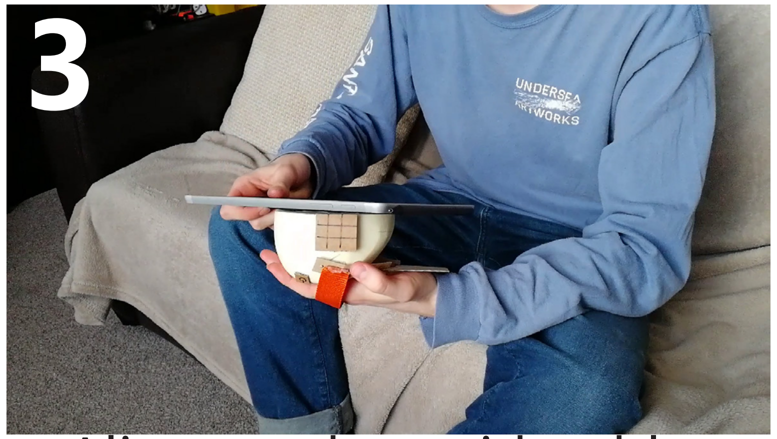


Companion Software

The product shall be packaged with a download link to a piece of companion software that is used to manage the shortcuts on the product. Within this software it is possible to define and assign shortcuts to keys, mange shortcuts within a profile and set each profile's corresponding LED colour.

User Journey

Insert hand into strap

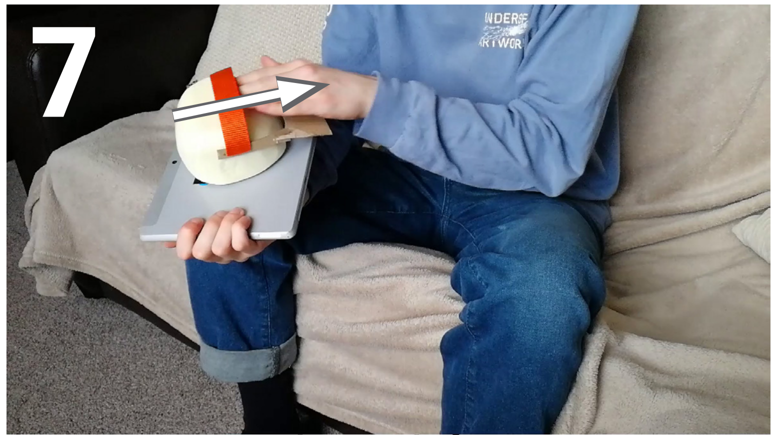


Align product with tablet

Attach using the wrist

Work may begin using shortcuts

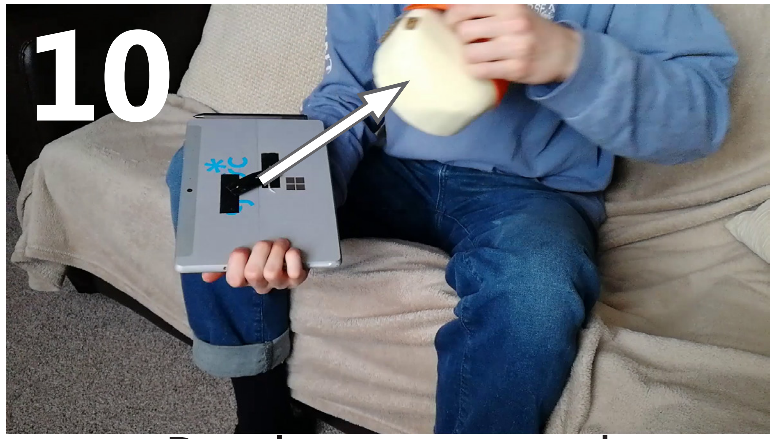
Rotate freely to any angle



Remove hand from strap

Turn off using power button

Lever lifted from underneath, detaching product

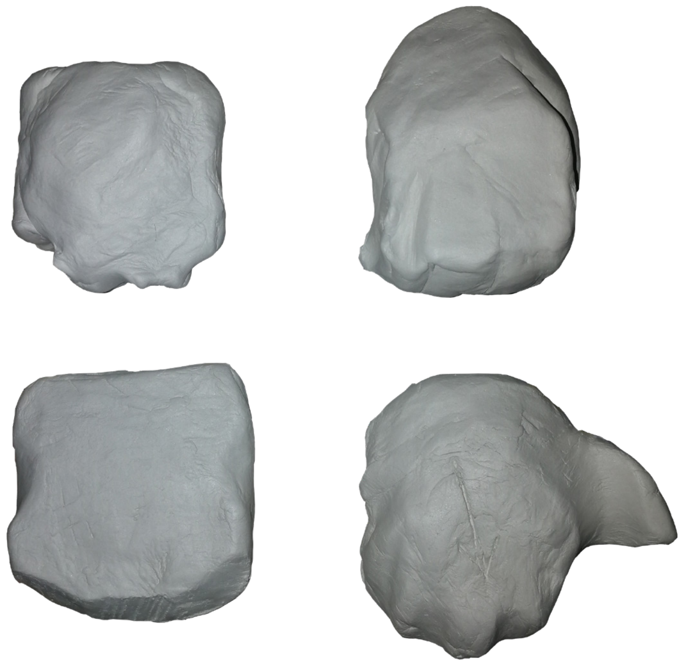


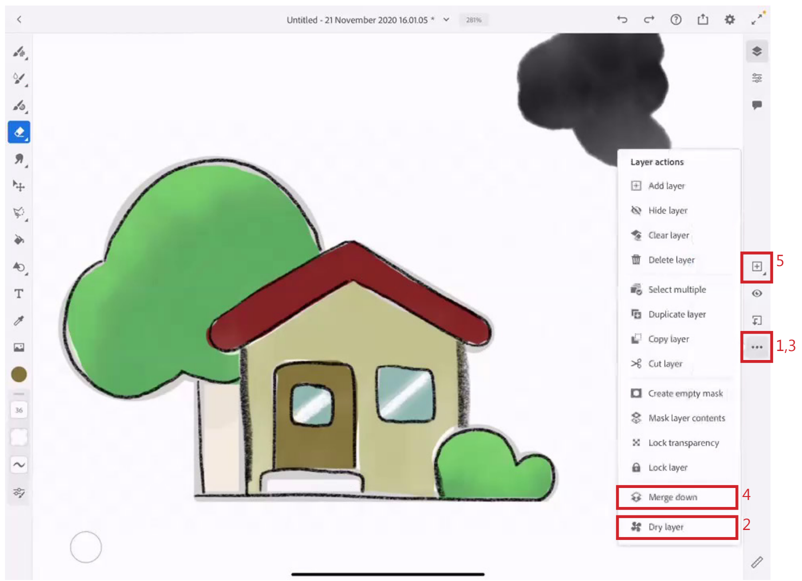
Product removed

User Focused Design

Co-Design

Co-Design with users allowed an insight to be gained into what forms feel natural within their hands, and what physical features are valued. A simpler shape with a wide body was the general form favoured by users. Along with this a taller design allowing the hand to form a grip and stretch out the fingers is preferred.



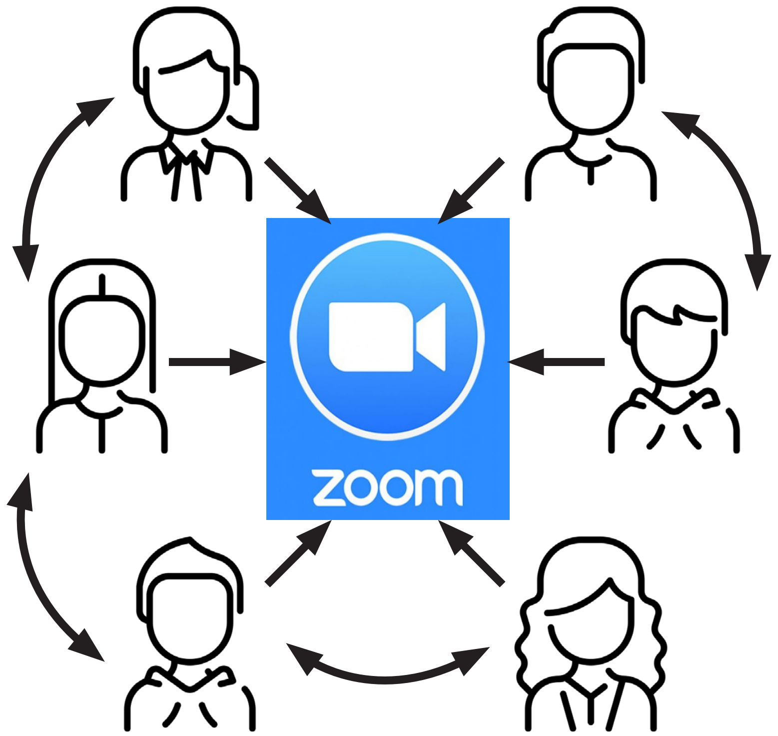


User Recordings

Users were recorded over Zoom while completing design work within their chosen program. Through this it was discovered that many treat the tablet like paper and physically rotate it, leading to a design requirement of being able to be rotated when desired. It was also found that through the reduction of one 5-tap processes, repeated 8 times over a 10 minute call, to a single macro on the product, 2 minutes could be saved.

User Network

A network has been created from within and outwith the PDE community. This link to a wide pool of users allowed for constant feedback on design elements.



Constant Feedback System

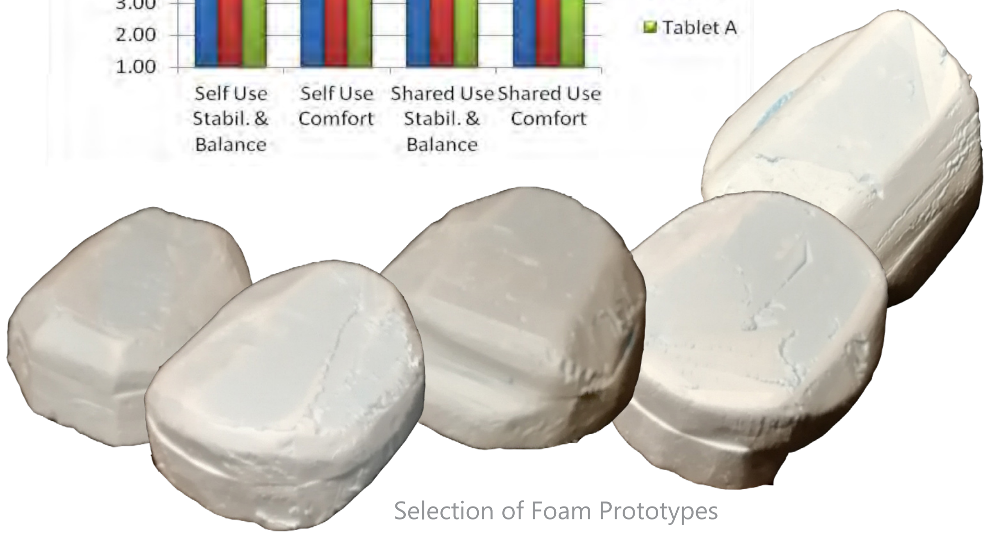
Flatmates have been used for a constant method of evaluating physical designs. Including product size and shape, button positioning/ sizing, necessity of a strap and methods for distinguishing buttons

Ergonomics

Shape

Analysis of a Verizon Wireless study into the most ergonomic tablet holding style for use within their retail shops highlighted that, a rear mounted graspable shape with a strap results in minimal muscle exertion and the highest user satisfaction rating, verifying the style used. Design criteria are given by Verizon to ensure an ergonomic form is achieved, including the need to avoid sharp edges that can cause stress concentrations on the hand. It is for this reason the lever has been ensured to fit flush to the body when in its lowered position. The final form has been verified through product testing and anthropometric data employed to ensure the product caters to those that lie between the 5th to 95th percentile smallest and largest among Western communities.

Verizon wireless Tablet C

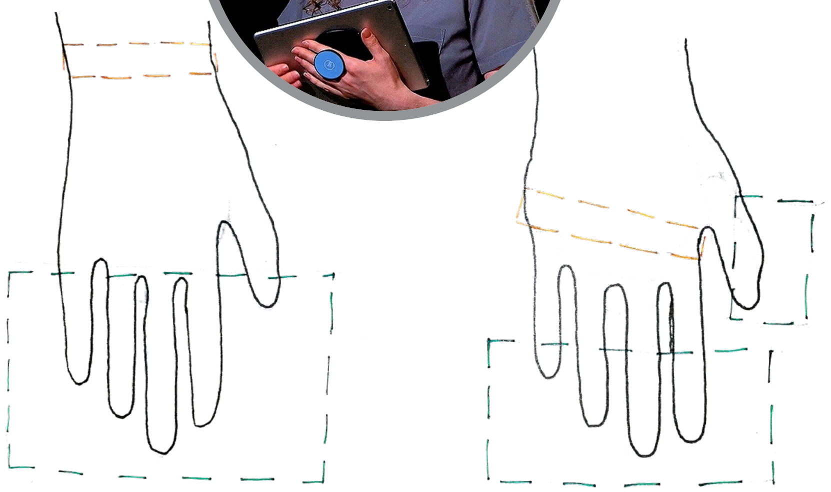


Selection of Foam Prototypes

Button Layout

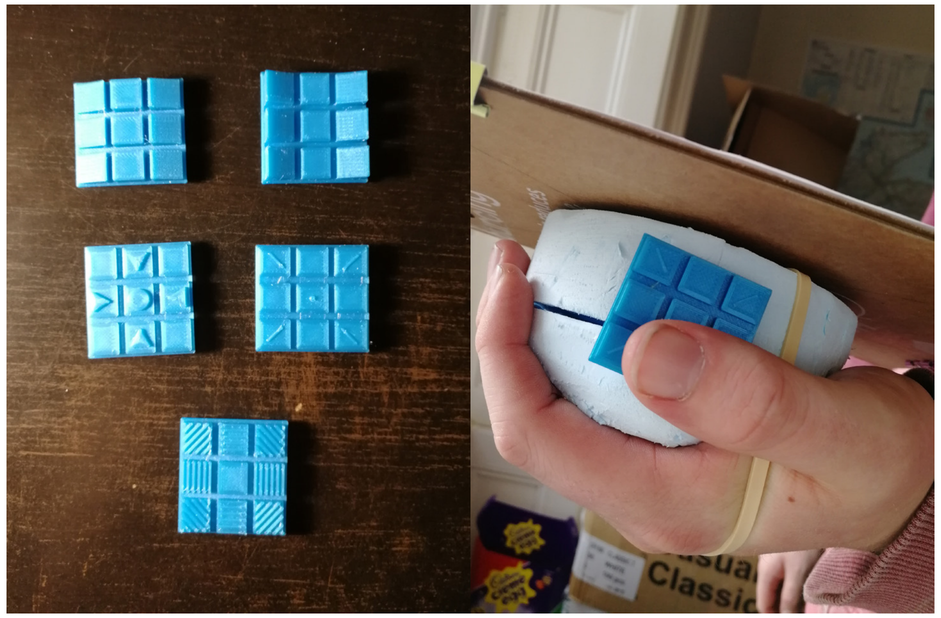
Button locations were considered in a range of layouts under the fingers and thumb. However after discussion with Alison Grieve, CEO of G-Hold, an ergonomics-focused tablet grip producing company, it became clear that avoiding fingers locking up by hovering over buttons and allowing them to adjust their position over time is key to avoiding long term damage, therefore only thumb buttons are included.

Alison Grieve, G-Hold CEO



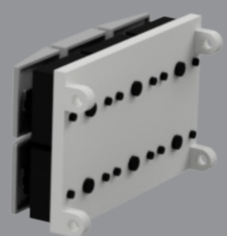
Button Saliency

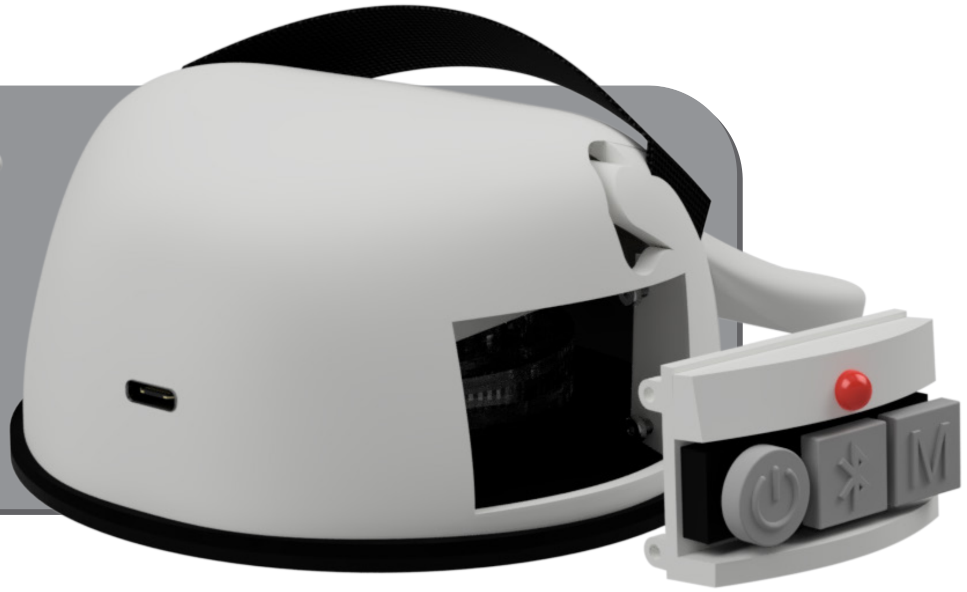
To ensure users are able to distinguish between buttons when obscured from view by the tablet during use, care has been taken to design a system to easily clarify between buttons. The final style is a combination of the best elements of those tested. The buttons are angled to fit the form of the body and avoid stress concentrations from their sharp corners. Dimples are added to the central column to aid in feeling the relative positions of different buttons.



Left and Right Handed Solution

Through designing a symmetrical form with button panels in mirror positions of each other, the product may be tailored to right and left handed users during assembly.

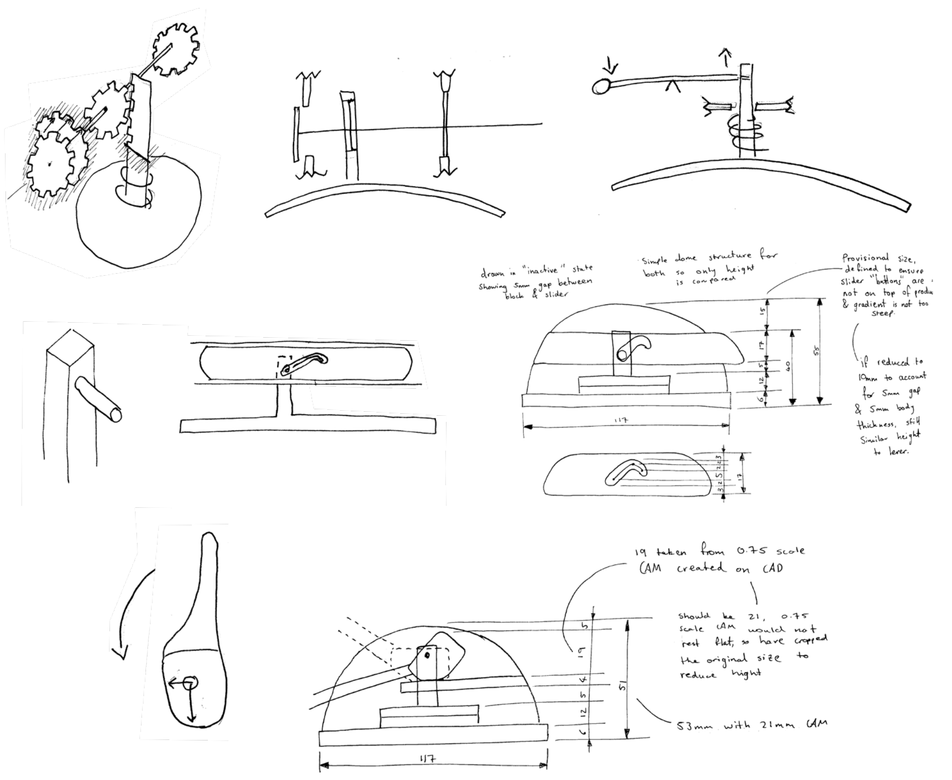




Mechanism Investigation

Suction Activation Method

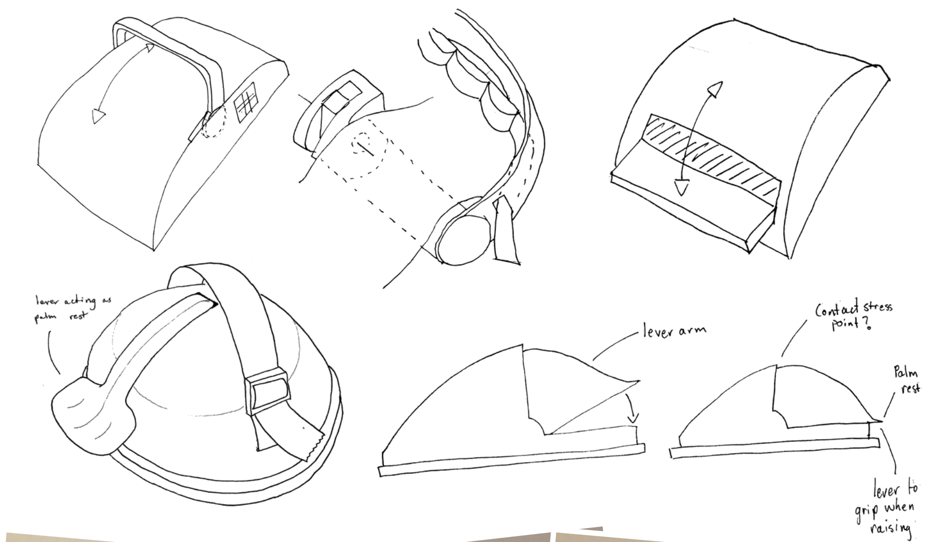
A range of suction cup styles have been tested on different makes of tablet to ensure that they provide a viable solution for mounting securely. The conclusion is that a suction cup, activated by lifting the centre through a physical mechanism is needed to ensure the product stays mounted for extended periods of time. Many activation methods were designed and analysed, but a lever arm and rotating CAM proved the optimal as it can be designed to be the most inclusive, controlled with one hand and requiring minimal strength to apply.

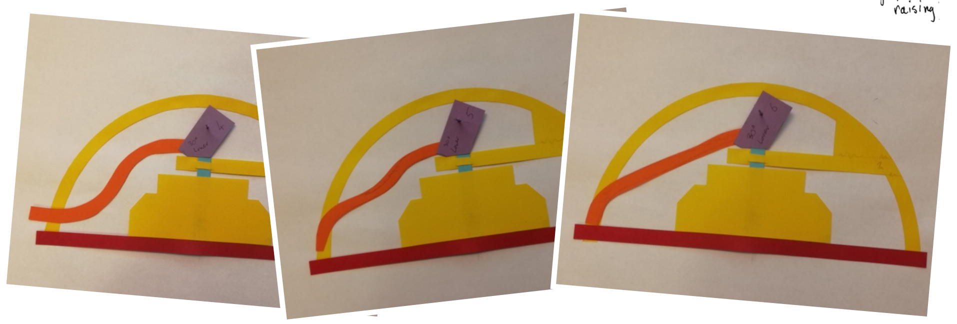


CAM & Lever Design

A lever and CAM that rotates towards the tablet to activate the suction cup has been analysed against a raising motion through cardboard prototypes and user testing. The lowering style chosen eliminates the need for any strength in the fingers by using a rotation of the wrist to activate.

Functional 2D scale prototypes have been used to determine the minimum CAM size, clearances and rotation angle possible. A lever shape that is straight and protrudes from the base of the product when lowered was selected for its ease of operation and comfort while in use.

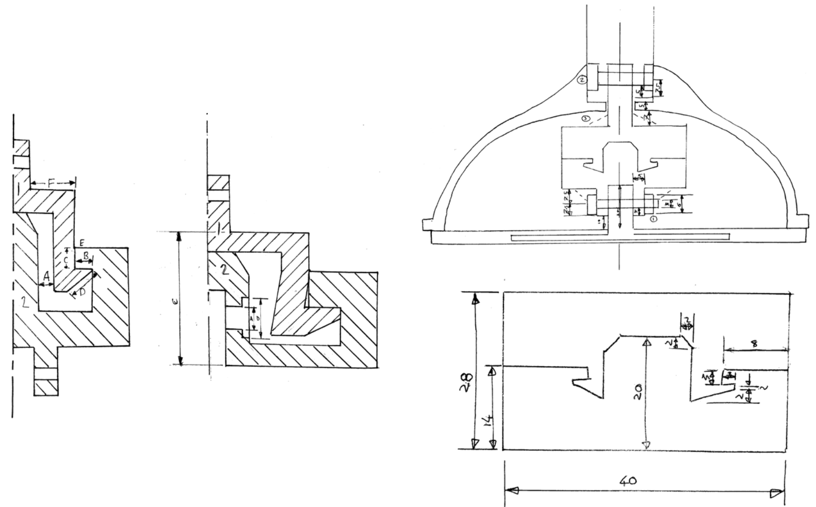


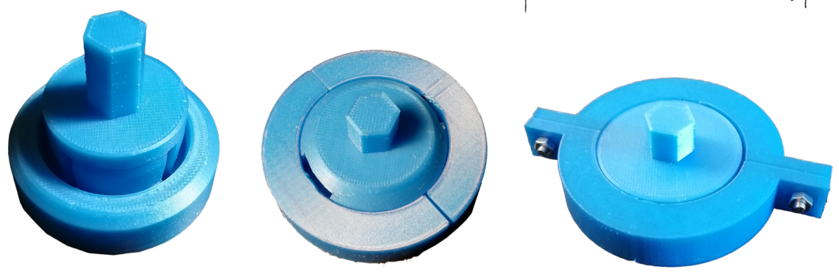


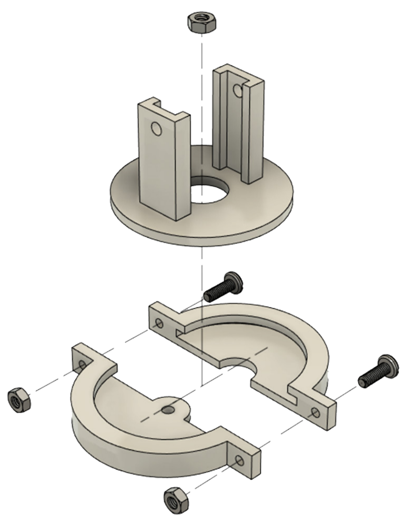
Rotation

A range of methods of enabling product rotation were discussed with workshop staff and it has been agreed upon that the design of a rotating block, featuring between the static suction cup base and rotating body and lever is the most feasible approach.

Iterative 3D prints and scale drawings have resulted in a 3 part rotating joint existing within the minimum vertical space possible, and in an easily disassembled style for increased repair ability.







Suction Testing

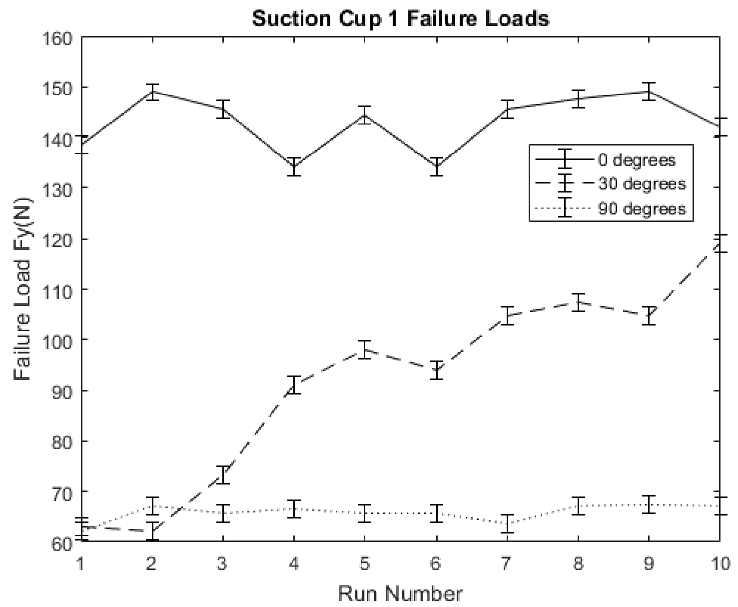
"the vacuum area of the suction cup in the attached phase is proportional to the magnitude of the pulling force."

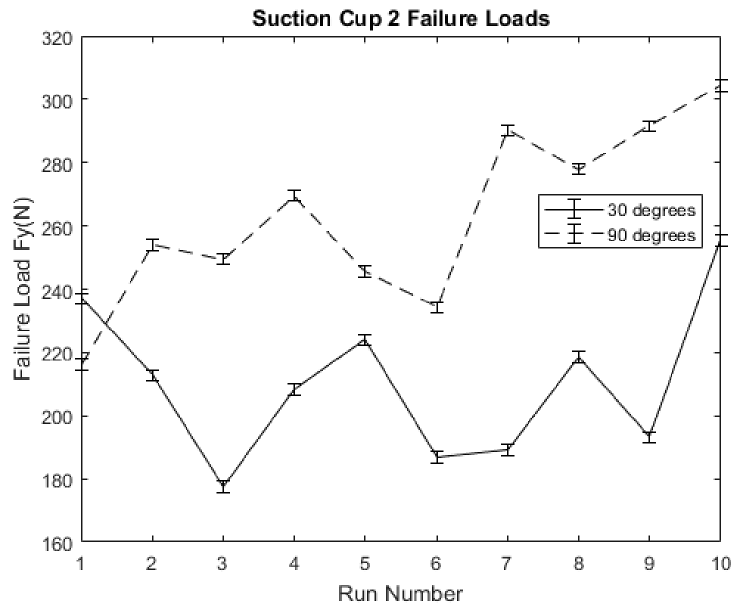
-Dingxin Ge, Ritsumeikan University, Japan

Through discussions with users it was clear during development that unless the mounting system is trusted completely, then they would never use the product as intended. To ensure the tacta mounts securely and there is no risk of detaching, dropping and damaging the connected tablet, analysis has been performed to calculate the necessary minimum diameter for use.

An extreme-use case has been developed to simulate the forces on the surface between suction cup and tablet. Calculations are based on a user with arm length equal to that of a 95th percentile man swinging the product, with tablet attached, above their head. With the inclusion of a generous safety factor of 1.5, the necessary mounting force required in the cup is 177N.

Failure load testing of existing industrial suction lifters, at a range of angles, for two diameters of suction cup was completed. From this and the use of equations within existing literature a necessary suction cup diameter of 107mm was defined. This dimension constrained the design of body size and shape.

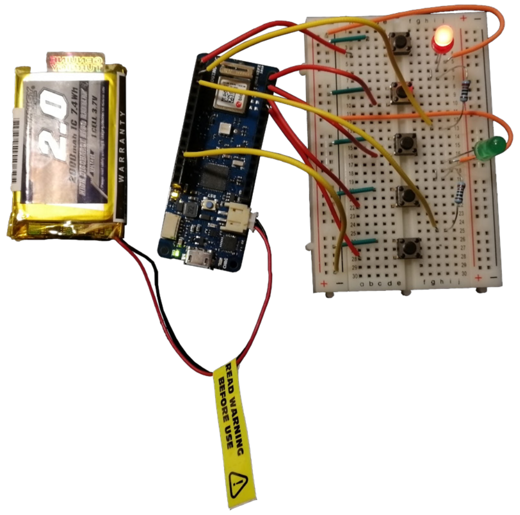


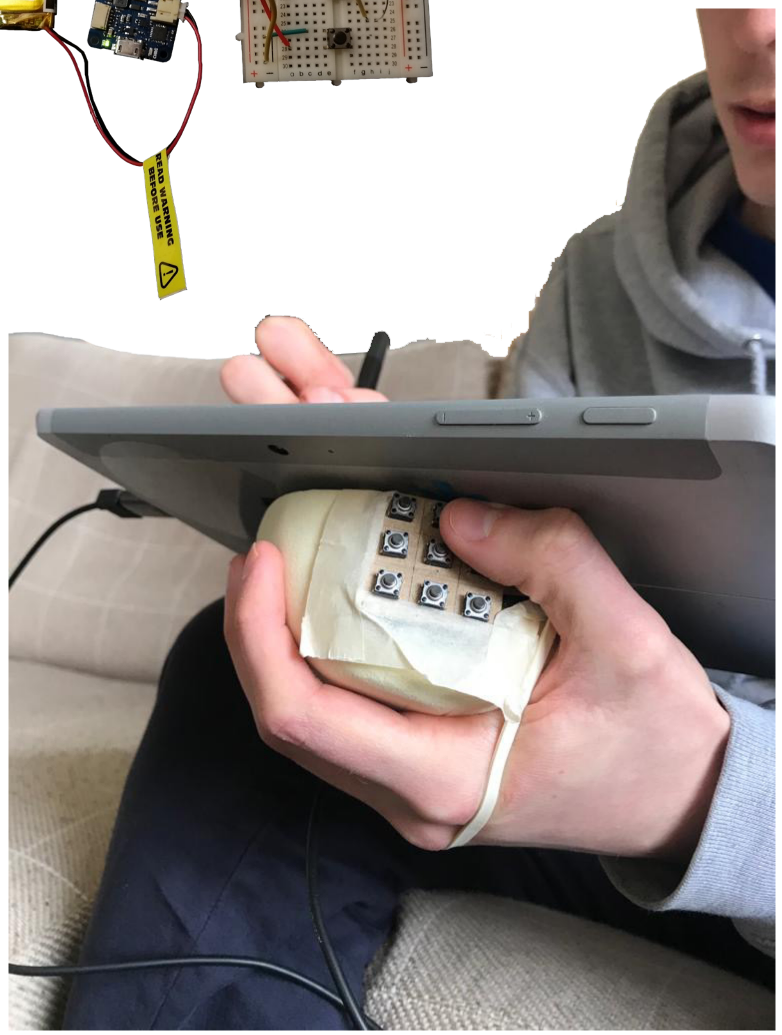


Electronics

Prototypes

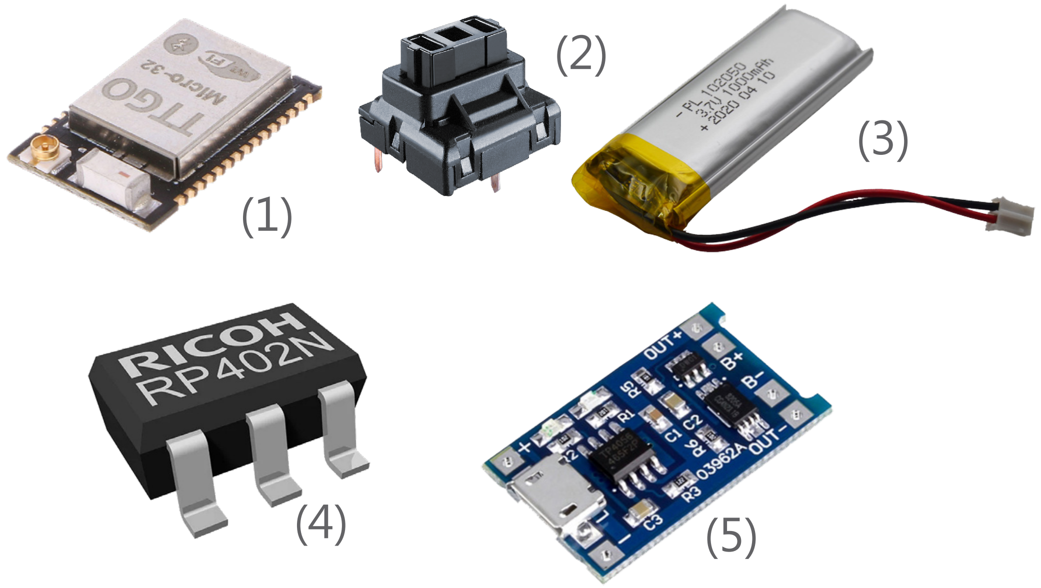
Use of electronic prototypes, developed with an Arduino MKR 1010, allowed for the product to be tested as it is intended to be used. Shortcuts were defined to assist with my own digital creation, including helping to create this document. Done through reducing the repetitive work-flow of removing backgrounds from sketch scans and photos. One button duplicated the background layer, toggled its visibility, activated and applied the threshold command to remove all pencil lines, resulting in a black-and-white final image.



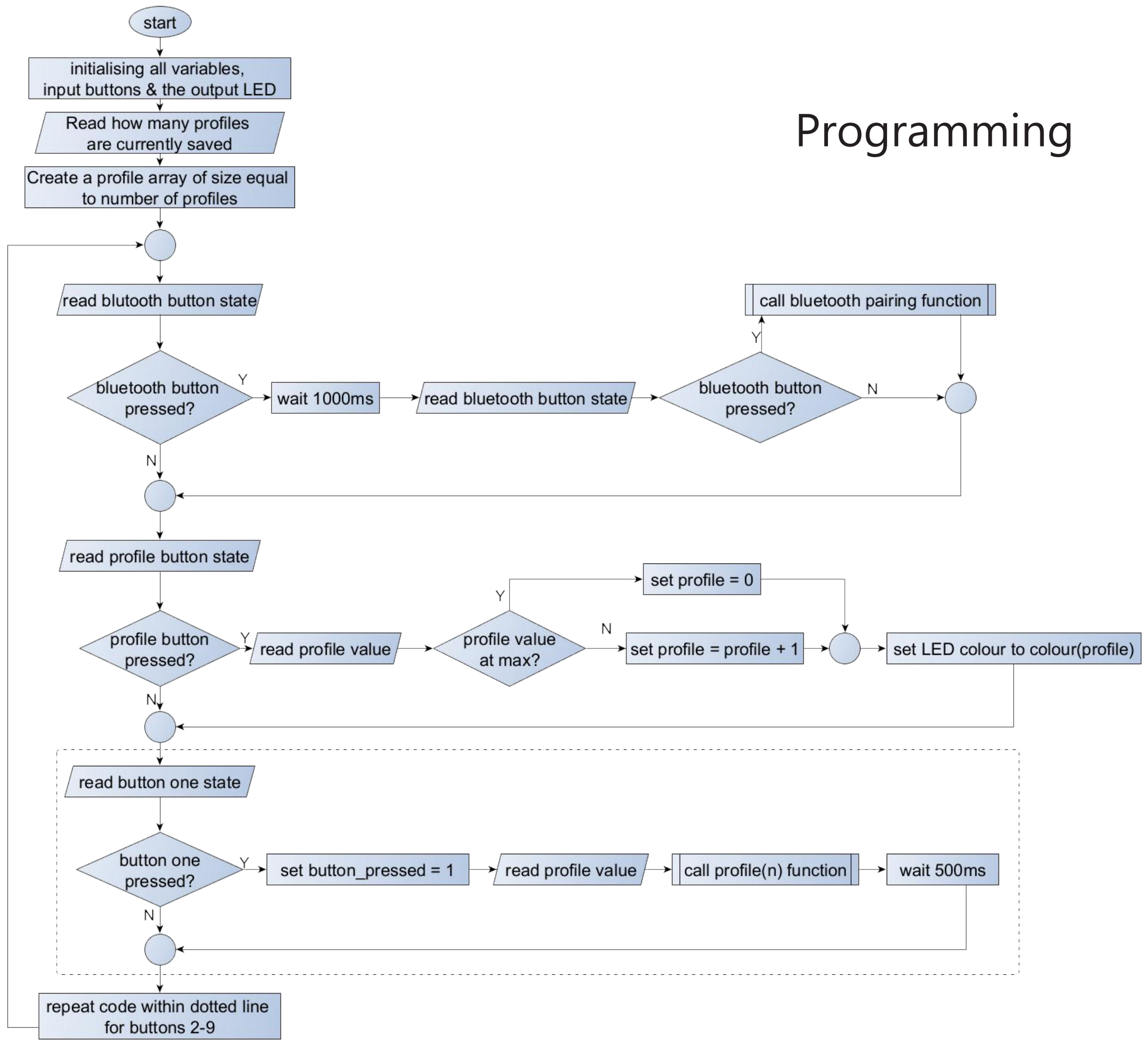


Components

The product is driven by an ESP32 MCU (1) featuring beneficial Bluetooth functionality, aligning with market expectations, and on-board memory large enough to store 17 profiles. For their slim form factor, satisfying tactile click and connection to a market leading name, Cherry ML Mechanical switches (2) feature as the buttons. This is all powered by a 3.7V 1000mAh rechargeable LiPo battery (3), stepped up to the required 5V through a boost converted (RP402N)(4) and charged through a USB-C battery charger (TP4056)(5). The costing for all eletrical components based on an initial product run of 1000 is £9.96.



Programming



Software flowcharts outline the operation of the device while in use, this flow is constantly looped to poll for button presses while powered on. Profiles are defined through individual subroutines for ease of altering and deleting by the companion software, without needing to alter the main code.

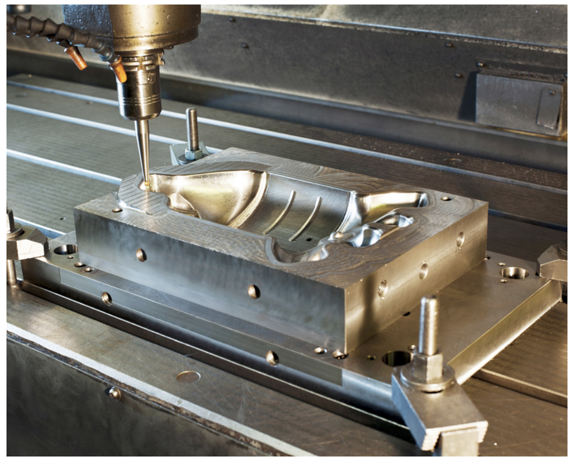
Delays are included after completion of a button's function to avoid executing a shortcut multiple times from registering a single press repetitively during the duration of being pressed. Delays are also included within shortcuts, between key presses, to allow time for user interface animations to complete and avoid keys not being registered during animation.

Materials & Manufacture

PLA & CA

To offset the environmental issues surrounding consumer electronics ending up in landfill at end of life, the biodegradeable polymers PLA (Polyactide) and CA (Cellulose Acetate) are used. The PLA used has its polymer structure controlled to avoid biodegrading through UV and water exposure, but maintaining degradation by natural enzymes. Allowing for an end of life scenario as a compost filler when added, by weight, under 30% and to ensure decomposition when added to landfill. CA is beneficial for its lower cost, however it is only used within internal components due to its transparency.

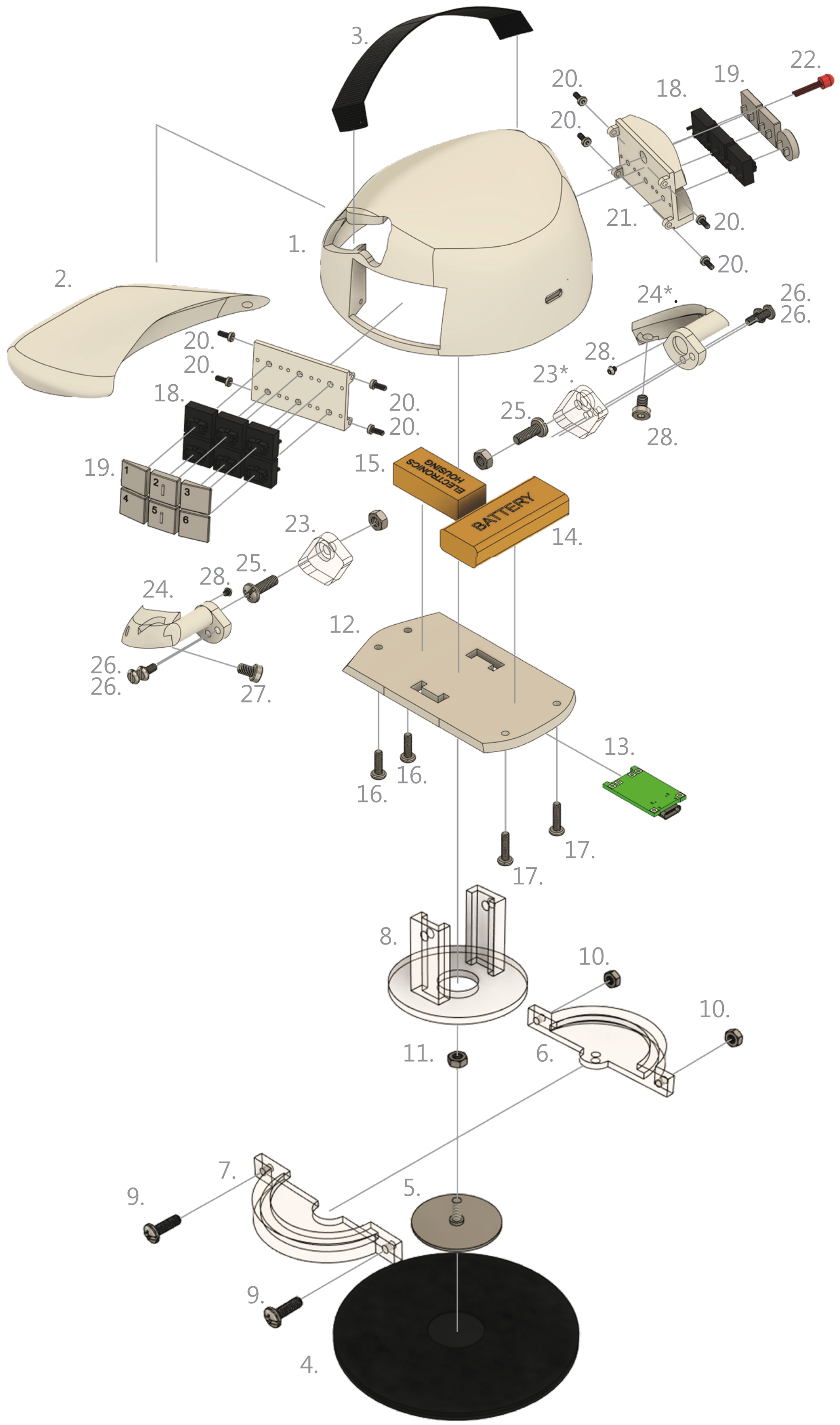
Injection Moulding



Injection moulding is a common production method for consumer electronics made out of polymers due to low cost per part once the machines are set up and being able to produce a high quality surface finish. Injection moulded parts are designed with a constant wall thickness to avoid warping during cooling, and without overhangs, to allow for a straight pull mould, keeping costs minimal. Draft angles of 2° ensure friction marks are avoided during mould ejection.

Butyl Vulcanised Rubber

Butyl rubber is employed for its low oxidation compared to other rubbers, providing the cup protection from losing its critically important elasticity over its lifespan. Exceptionally low gas permeability, its resistance to gas particles penetrating through the material, ensures the internal pressure fixing it to tablets will be maintained over long periods of time. The suction cup is vulcanised and moulded immediately after, with the base pin in position within it. Bonding the two together ensuring the cup is able to be raised as needed through raising the pin, done by the CAM's rotation.



Part No	Part Name	Material	Quantity
1	Body	PLA	1
2	Wrist Rest	PLA	1
3	Strap	Woven cotton/ polyester mix	1
4	Suction Cup	Vulcanised butyl rubber	1
5	Base Pin	Zinc alloy	1
6	Rotating block base A	CA	1
7	Rotating block base B	CA	1
8	Rotating block top	CA	1
9	M3x12 Phillips head screw	Stainless steel	4
10	M3 hex nut	Stainless steel	2
11	M4 hex nut	Stainless steel	3
12	Electronics mounting plate	PLA	1
13	Battery charger	various	1
14	Battery	various	1
15	Electronics	various	1
16	M3x10 Phillips head screw	Stainless steel	2
17	Switch mounting plate	PLA	1
18	Cherry ML Switch	various	9
19	Button Cap	PLA	9
20	Low-profile M2x5 shocket head screw	Stainless steel	8
21	Switch and LED mounting plate	PLA	1
22	RGB LED	various	1
23	CAM	CA	2*
24	Lever arm	PLA	2*
25	M4x12 Phillips head screw	Stainless steel	2
26	M3x6 Slot head screw	Stainless steel	4
27	M4x6 Low-profile socket head screw	Stainless steel	2
28	M2x2 Button head hex drive screw	Stainless steel	2

* Indicates a part with a mirror component included within part quantity