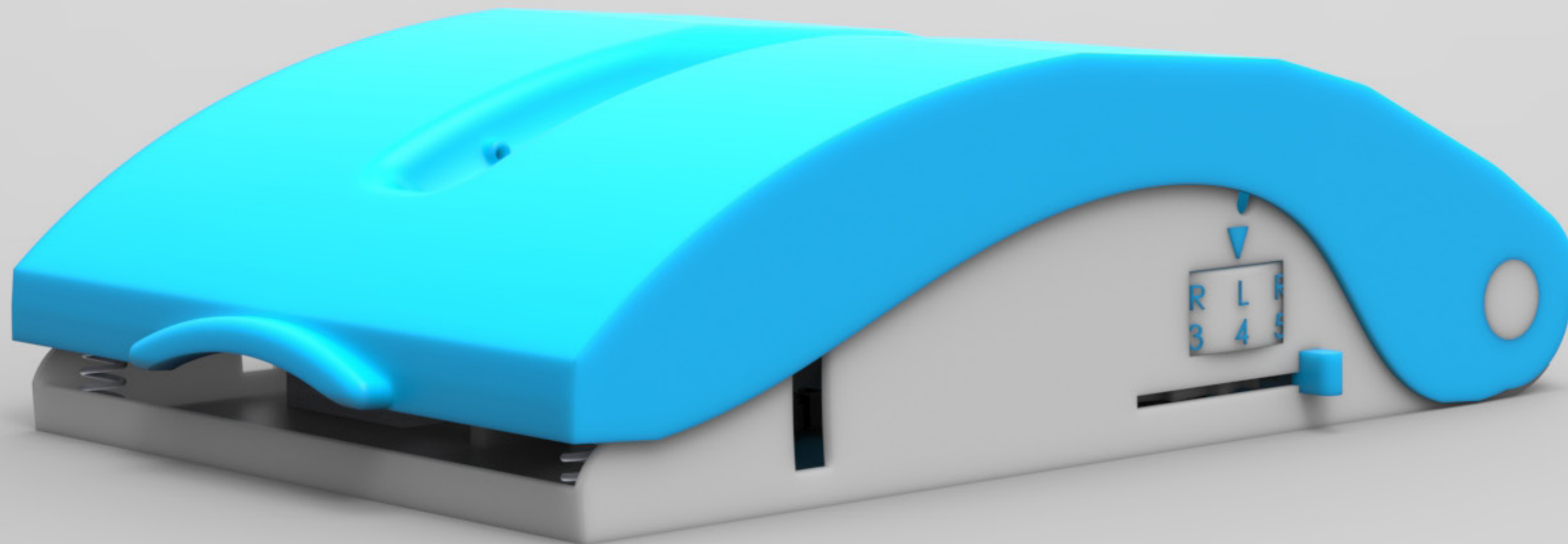


Improving diabetic management for those with reduced dexterity and eyesight

*Alfie Talbot
Product Design Engineering*



Contents

Diabetes	1
Scenario	2
The Problem	3
Requirements	4
Concepts	5
Modelling	6
Usability	7
Mechanism	8
Storyboard	9
Final Design	10

Diabetes

What is diabetes?

Diabetes is a disease whereby the patient is unable to regulate the glucose in their blood. It is caused by the pancreas not being able to make enough, if any, insulin. Insulin is a hormone used to store glucose in the body.

How do you manage diabetes?



Lancing device

Use a lancing device to pierce the finger with a lancet to receive a blood sample



Glucometer

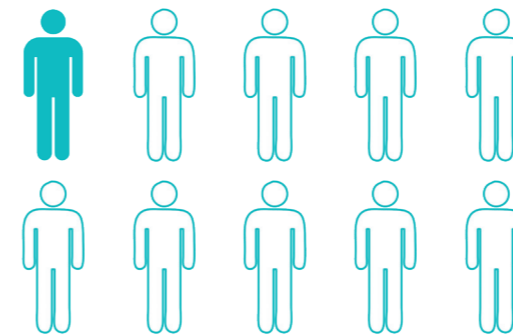
Use a glucometer to measure the glucose levels in your blood



Insulin pen

Use an insulin pen to inject yourself with the appropriate amount of insulin

Diabetes in the UK



1 in 10
adults have diabetes

There will be 5.5 million diabetics in the UK by 2030



10% of NHS Budget
is spent on diabetes and the complications of diabetes

£12.4m
spent on lancets alone in 2020

Symptoms

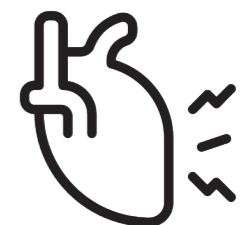
Not properly managing diabetes can lead to complications such as:



Eyesight loss



Arthritis



Kidney or heart failure

Scenario

The population of diabetic patients over 75 years-old is growing rapidly due to the fact that you are more at risk of getting diabetes with age. Also, the UK has an increasing aging population.



Managing diabetes over the age of 75 years-old

If a patient is unable to use the equipment to check their blood and medicate themselves, a nurse is required to visit them at home to preform these tests



Using a lancing devices was identified as the most difficult process in managing ones diabetes for people over the age of 75 years old



I only need to check my blood twice a day, once at dinner and once at breakfast but I struggle to use the lancing device so I can't do it.

Having to wait for a nurse to check my blood can interrupt my whole day if she's late



It's costs the NHS so much money having nurses visit peoples home to care for these diabetic patients

The lancing devices are designed to be so small, portable and for people on the go. It excludes the older demographic.

460,000



Diabetic patients are more prone to dexterity related issues

Diabetic patients over the age of 75 years-old live alone at home

The Problem

Under NHS guidelines, this is the most suitable lancing device for people with visual impairment or dexterity problems.

Each drum comes with 6 pre-loaded lancets. Which can be changed by sliding the dial.



Issues:

1) Users with poor dexterity will consistently use their strong hand to operate the device, resulting in over-piercing the same finger.



2) Users with poor dexterity struggle use their thumb to press the trigger



3) Users tend to have shaky hands so positioning the device in a controlled manner is difficult

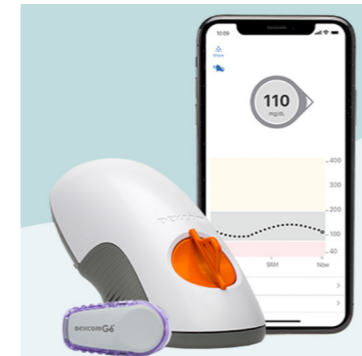


4) Replacing the lancet is 'fiddly'

Should other technologies be considered...

Continuous Glucose Monitoring (CGM)

CGM is a patch that attaches to the users arm with a sensor that goes under the skin. It measures the glucose from the fluid in the arm. Data is automatically sent to the users phone every 5 minutes.



A CGM costs £5 a day, where as using a lancet is only £0.20. Because of this the NHS only prescribe CGM to those who need it the most



The older demographic are intimidated by the new technology and the overexposure to excessive information



This tech is not 100% accurate. Patients are required to have a lancing device as a 'back up'.

The future of diabetic tech

I researched if there are any new technologies soon to be released, to see if I could incorporate any elements into my design. However, the research revealed that there hasn't any new innovations in the industry for a while.

Diamondtech claims to have created the first non-invasive blood glucose reading device. However, the product is years away from market, expected to be to the size of a shoebox and will come with a very high price tag.

Other economies and healthcare systems

This lancing device can benefit economies other than the UK. In USA they have a private healthcare system, meaning all the financial burden of healthcare falls onto the patient, meaning many will be unable to afford CGM or any other new diabetic technology. A low cost, dexterity orientated lancing device will benefit many people in USA.

Requirements

Design a lancing device to help improve the management of diabetes for the over 75-year-old demographic who have weak dexterity and poor eyesight.



Manufacturer



NHS



Home



Use



End of Life

The product will be manufactured in batches of 50,000 units. Design the product to be manufactured using suitable processes.

Over 2 million people of the ages of 75 years-old or older live alone and independently. Of this population 23% have diabetes.

There are 460,000 potential benefactors to this product so producing batches of 50,000 seems suitable.

Design the product to be manufactured using low cost materials and mass production methods.

The cost of prescribed consumables must be low to the NHS.

The NHS diabetic budget is under pressure to reduce costs.

Product must be safe to use

The NHS can not prescribe a product that is not completely safe to use.

- No accidental firing
- The product is hygienic
- Robust and durable

Product should blend into the aesthetics of a domestic home.

Users stated that they will only use the product at home, once at breakfast and once at dinner.

This product will be a common sight in the user's home so it should be designed with muted, subtle colours so not to clash with any design styles.

Must be easy to clean

Users want to be able to clean the product so it stays hygienic and pleasant to look at

Right and left handed

To suit all users

The product must be easy and safe to use for someone with poor eyesight and reduced dexterity

This includes releasing the trigger, and reloading the lancing device

The depth at which the lancet pierces the user's skin must be adjustable

Users have different thicknesses of skin around their fingers. The device should be adjustable to meet each individual's needs. Excessive piercing can cause unnecessary pain.

Multiple lancets stored in each load

Having many lancets loaded at once reduces the number of times the user needs to reload the product. It will also make it quicker and easier to change to a new lancet.

Design the product to be as sustainable as possible

Can the product be dismantled easily? Can the parts be recycled? And is the product manufactured in a sustainable way?

Concepts

These two concepts were the best. The design direction contained elements from both these ideas



This design explored the idea of fixing the device to the user's finger.

Pro:
The user can attach the device to their finger and take their time to release the trigger

Con:
The user stated using the 'clamp' feature would be difficult with reduced dexterity. And the design is too small to store multiple lancets.

This design explores having many lancets stored in one 'reload'. Each lancet comes with a 'self piercing' cover so the user doesn't have to remove the cover.

Pro:
The user doesn't need to reload the product as many times, a carer could even do it for them.

Con:
The product and mechanism will be more complex driving up price. Careful attention is needed to ensure the consumables aren't too expensive

This design only has one lancet. The lancet is self cleaning meaning one lancet can be used multiple times.

Pro:
One lancet could last a long time. The user doesn't need to replace it, they can throw it away after the recommended use.

Con:
There is no trigger mechanism, the user has to apply the force to pierce their finger. Is the lancet guaranteed to be sterile after each use?

Most users stated they perform the tests at the kitchen table or on the armchair. This is one-handed device was identified as the most user friendly and will be developed further

Pro:
The user can perform the test where they are most comfortable. Resting the hand on the product will overcome the difficulties of having shaky hands

Con:
The product is bigger and less portable (however users nearly always perform these tests at home).

Ergonomics

Having a device that could be operated with one handed was chosen. The device should rest on a surface and the trigger should be activated using one hand.

Anthropometric data was used to design the initial models

Basic form



Curved form



Wrist support



Shallow shape



Ergonomic form

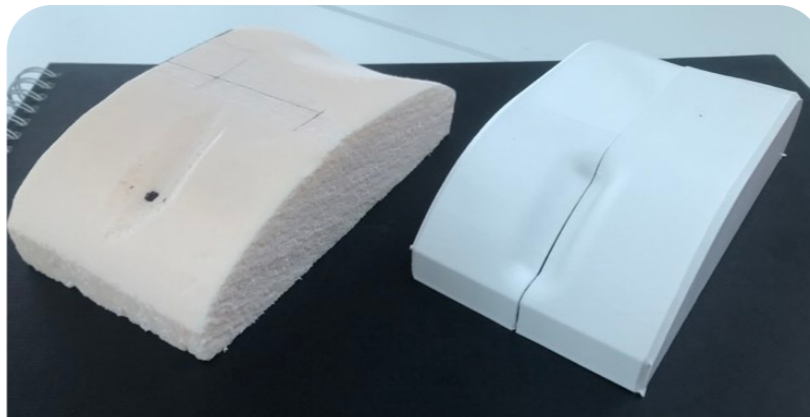


This design took into account the natural curve of the hand.

An indent has been made so the palm can rest comfortably.

A groove has been made to indicate to the user where to place their finger

Further refinements of the model shape were made. The final design was 3D printed so that manufacturers have defined dimensions to work from.



The design needs to be wider to accommodate all hand sizes

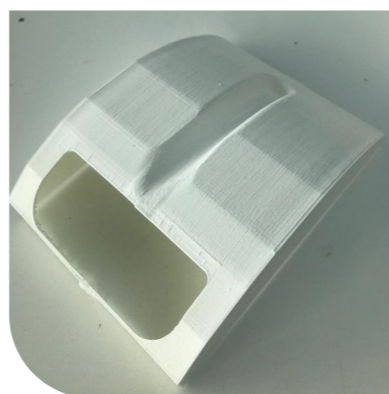


The finger groove needs to wider



The arch shape in the side profile is too steep

Final form design:

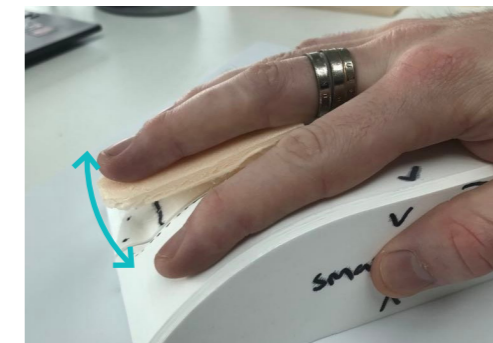


Different methods of triggering the release of the lancet were tested



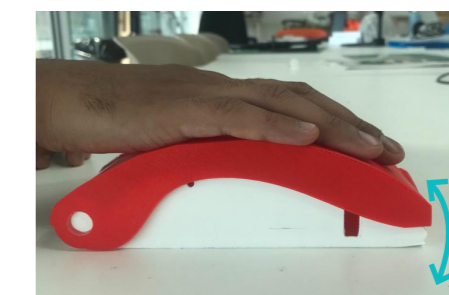
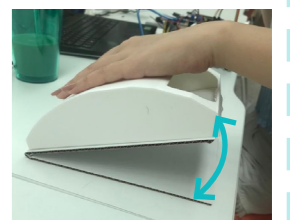
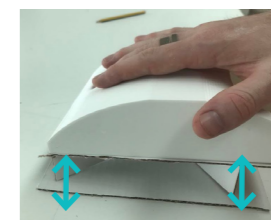
The user pushes their palm against a paddle on the back of the product.

Users struggled to bend their wrist enough to activate it



User push their finger downwards to trigger the lancet

Users didn't have enough dexterity to comfortably perform this action

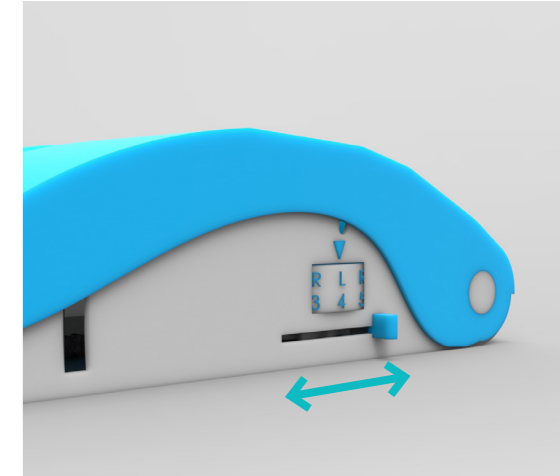
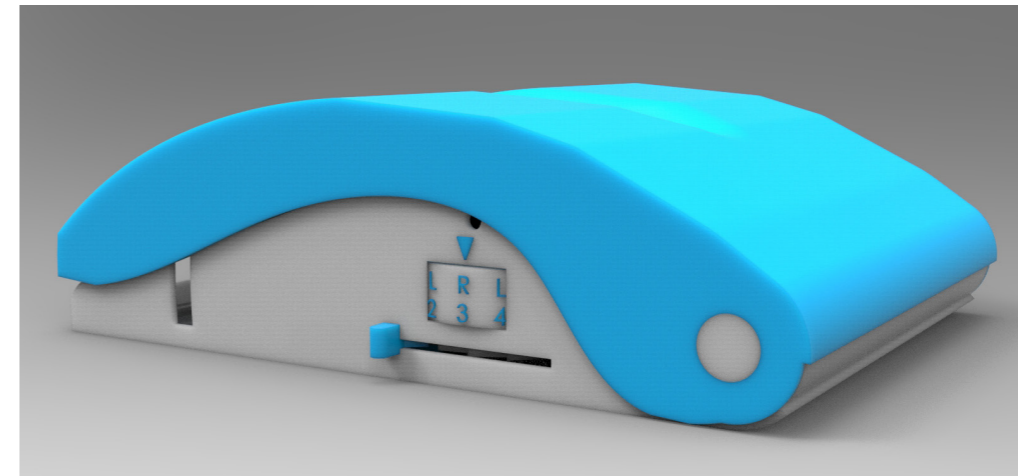


This design was the best. Users rest their palms on the back of the product and apply a force through the whole hand. This trigger was the least strenuous and most controlled.

Usability



Multi-lancet drum



The device has 20 lancets per drum, the Accu-chek Fastclix only has 6. This means users must endure the task of replacing the drum less frequently, only once every 10 days. Or alternatively, carers can replace the drums for their patients with the peace of mind knowing they'll be ok for a long period of time.

To change the dial, slide the knob forwards and then backwards. This motion has been selected because it is simple to perform for users with arthritis. The knob is a large size and the user doesn't have to grip it, just simply push it.

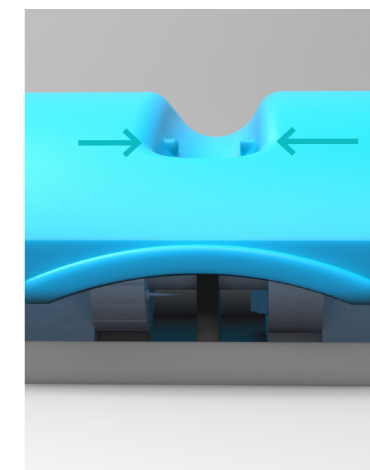
Safe and comfortable piercing



Research showed that users with poor dexterity tend to hold the lancing device in the same hand, in the same position, which resulted in over 'pricking' on a particular finger in the same spot - which can cause callousing.



This Lancing Device is designed so that the user can use the product easily with both hands.



The device also ejects lancets into the users fingers in both the left and right hand side.

There are bumps positioned on the device to help the users with poor eyesight locate the exit holes.



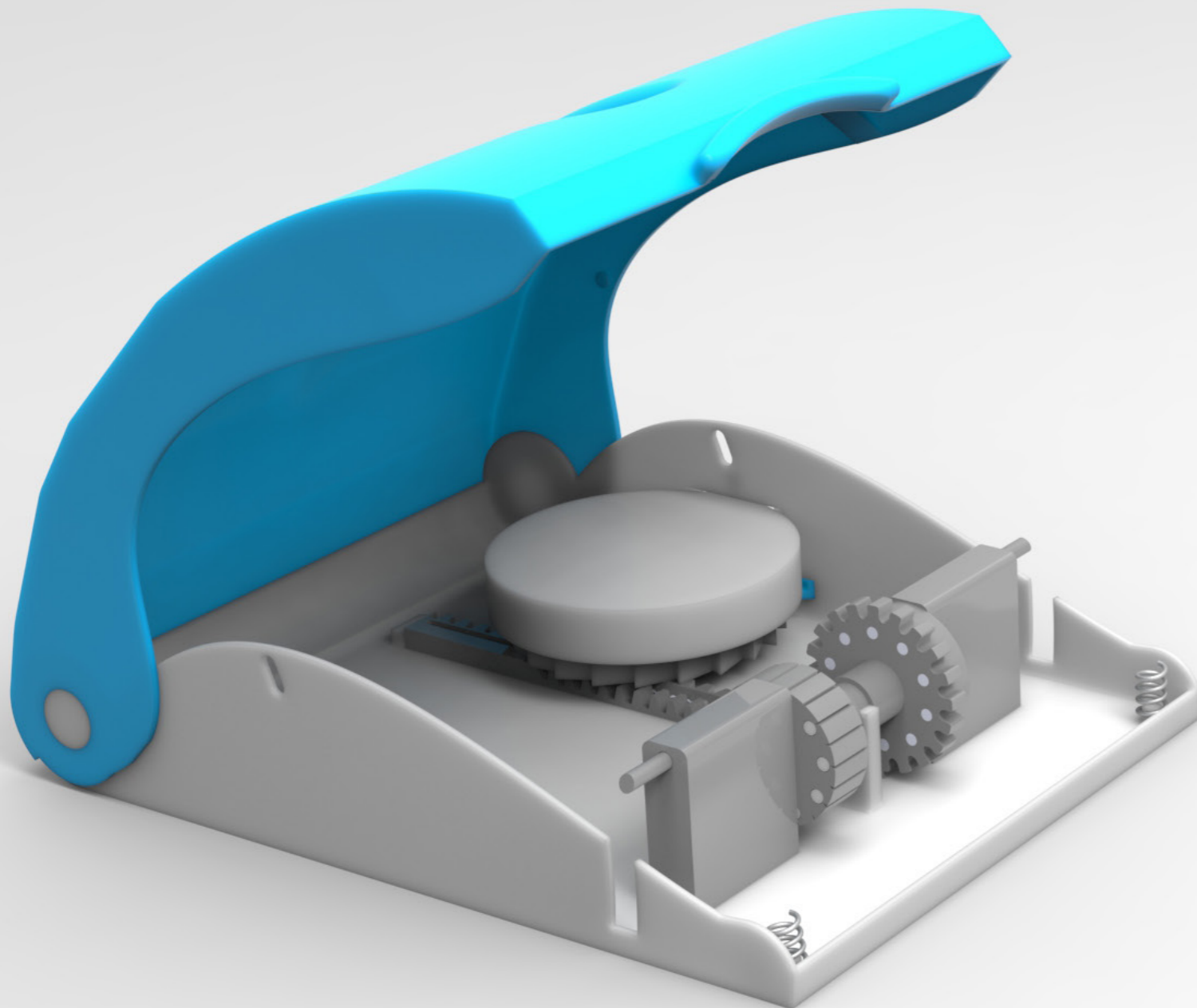
Having a device that is easy to use with both hands and automatically alternates the location of the piercing will create an even spread of piercing.

Protecting the users hands in the long term.

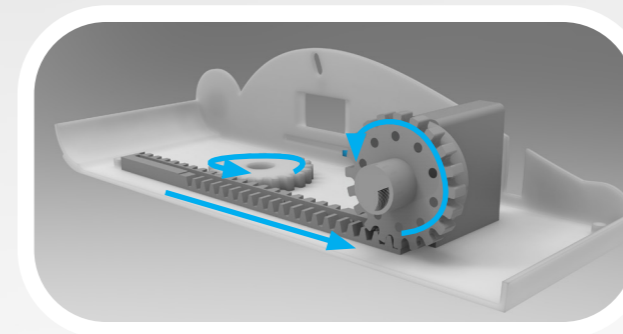
Mechanism

Creating, designing and prototyping a working mechanism to meet the safety and usability requirements of the lancing device was time consuming and strenuous.

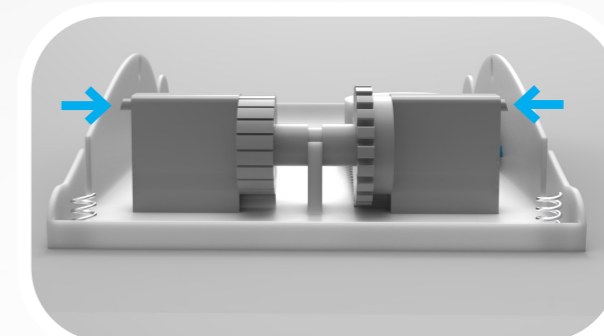
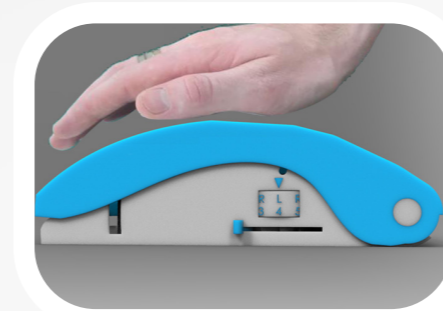
The mechanism underwent many iterations to arrive at the design here, this design is a realistic prototype with considerations made to clearances, material use and user interactions.



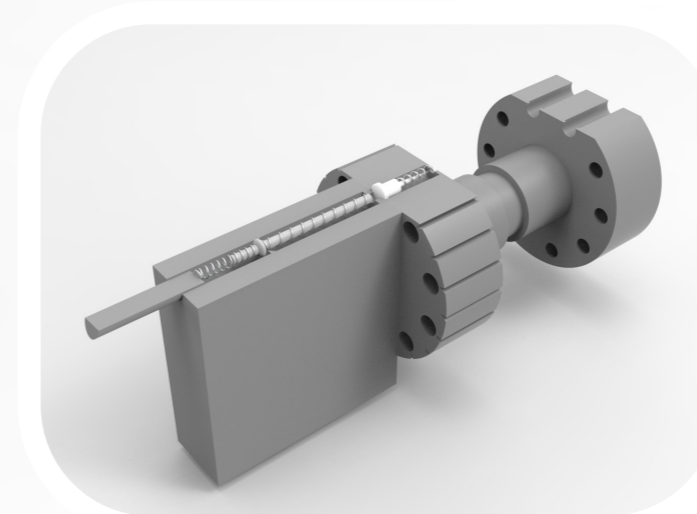
Sliding the handle will cause the ratchet to rotate



This will load a new lancet



Force from the hand is used to trigger the device

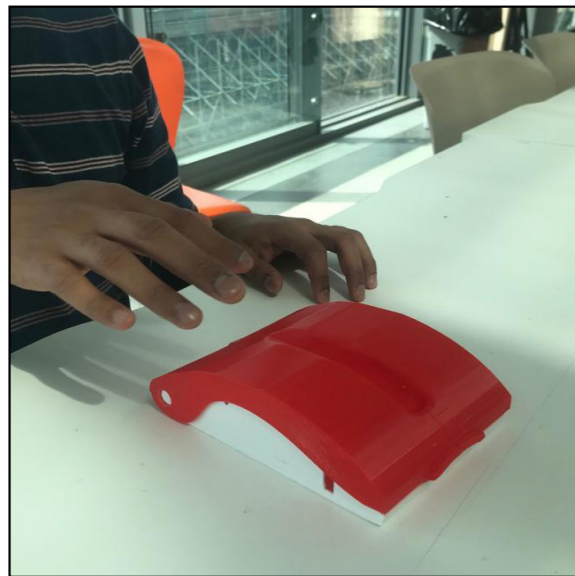


Causing a lancet to eject into the users finger before quickly retracting

Storyboard

How to use the product

**The product was modelled in red but this is not the final colour*



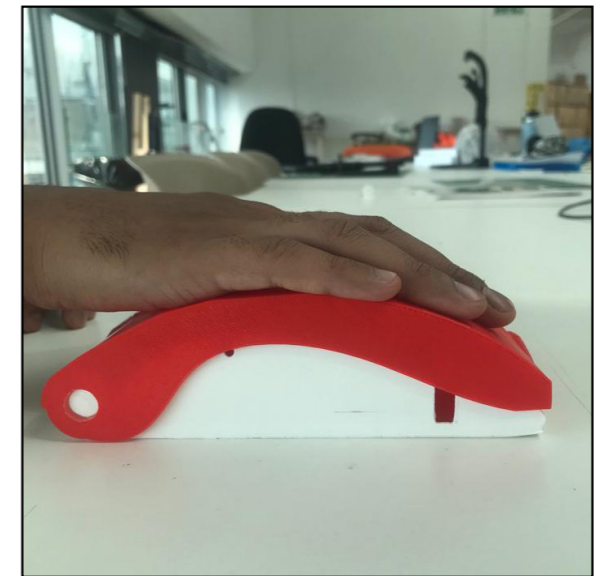
Place the product down



Change the lancet to a new, unused one

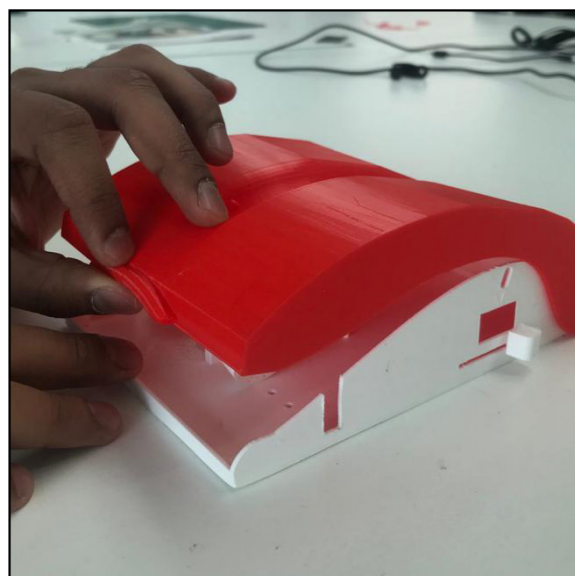


Place hand on the product

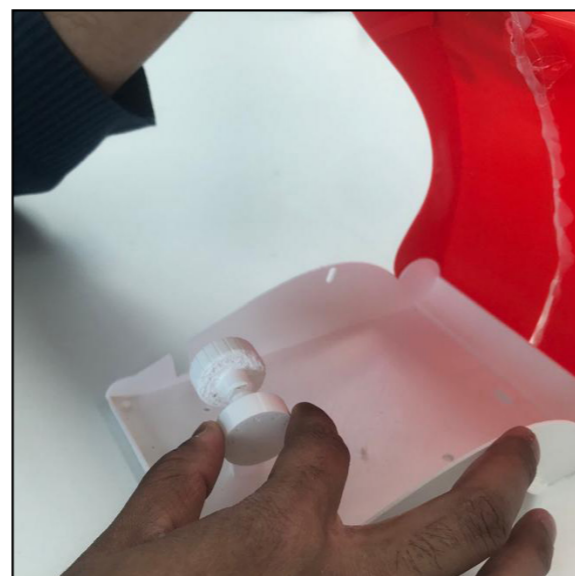


Apply a downward force to release the lancet

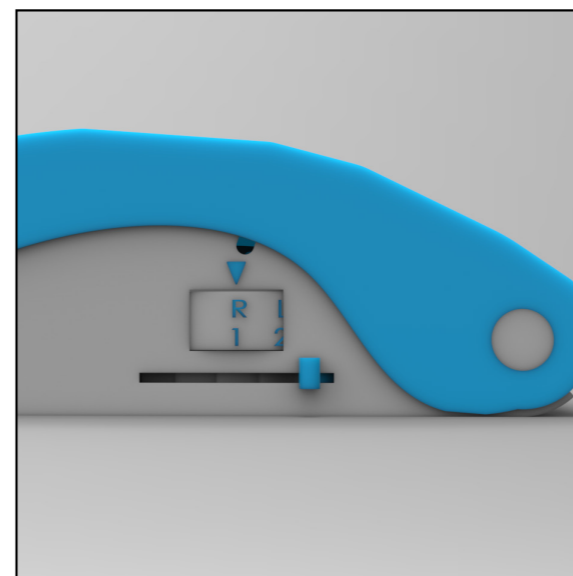
How to replace the drum



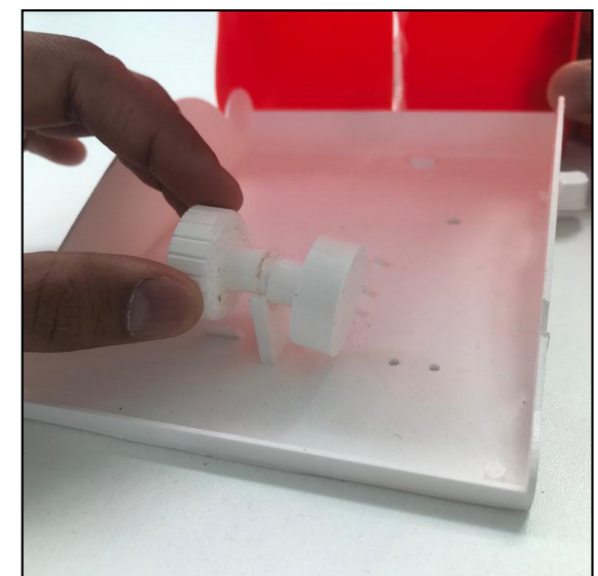
A large 'flap' has been specifically designed to be easily gripped



Pull the drum out the product

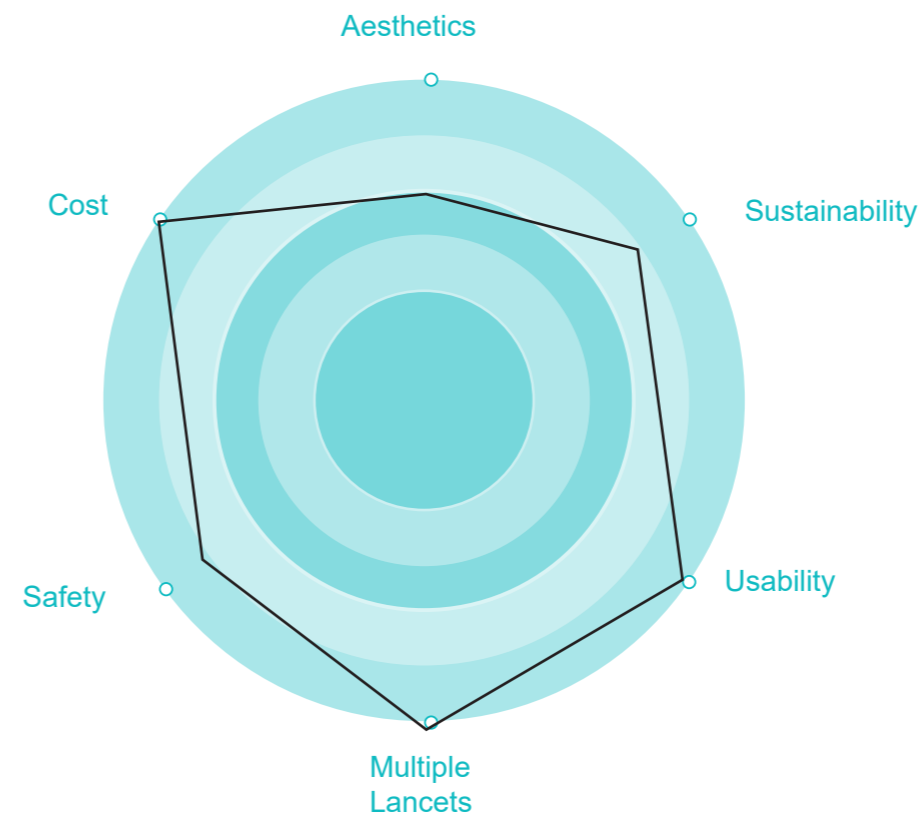


The internal mechanisms will reset the lancet dial back to '1'



Place a new drum in the product

Final design



The product is designed with the user in mind, it accommodates their reduced dexterity and gives them independence when managing their diabetes.

The product is primarily produced from PP, which is inexpensive and suitable for mass production with injection molding etc. Therefore the product should be low cost to produce.

However, the products aesthetics are not adaptable to most homes. The white and blue colour can be portrayed as too 'medical' and comes across sterile.

In terms of use, the product it is safe. The sharp lancets are always covered and pose no threat to the user. The lancets are designed to penetrate the users fingers at the minimal depth for only a split second.

Future Improvements



Some users did state that they had usability issues with glucometers, could the glucometer be incorporated into the design to resolve these issues? Having a one-device-does-all is a great way for patients to keep organised.



Information on which side the lancet is being released is given on the side of the product. It would be more user friendly to have this information displayed on the top of the product where it is easiest to read when sitting down.

Image sources

Diabetes

Lancing device

<https://www.pexels.com/photo/healthy-dawn-man-person-6823480/>

Glucometer

<https://www.pexels.com/photo/healthy-person-woman-hand-6823516/>

Injection:

<https://www.pexels.com/photo/man-person-people-woman-6823408/>

10% of NHS budget

<https://www.pexels.com/photo/composition-of-tools-for-blood-sugar-measurements-6303715/>

Eyeball

https://www.pngitem.com/middle/TowJwi_eye-mission-vision-view-idea-future-search-find/

Hand arthritis

<https://www.istockphoto.com/search/2/image?mediatype=illustration&phrase=arthritis+hands>

Problem

LANCING FINGER:

<https://www.pexels.com/photo/woman-piercing-finger-with-glucometer-lancing-device-6303706/>

Nurse and patient

<https://www.istockphoto.com/photo/health-care-patient-holding-hand-gm1263483893-369837487>

Nurse:

<https://www.pexels.com/photo/photo-of-woman-wearing-protective-goggles-and-mask-4270088/>

Analysis

Prescription facts about accu-chek fastklik:

Berkshirewestccg.nhs.uk. 2020. NHS Berkshire West Lancet Formulary September 2020. [online] Available at: <<https://www.berkshirewestccg.nhs.uk/media/4618/poc-clindoc-062-bw-lancet-formulary-september-2020.pdf>> [Accessed 23 July 2022].

nhs.uk/media/4618/poc-clindoc-062-bw-lancet-formulary-september-2020.pdf> [Accessed 23 July 2022].

CGM cost:

<https://www.healthline.com/health/diabetes/dexcom-g6-cgm-product-review>

CGM tech intimidating

<https://www.medindia.net/patientinfo/continuous-glucose-monitoring.htm>

Lancing device

<https://www.pexels.com/photo/composition-of-tools-for-blood-sugar-measurements-6303715/>

Brief page

Manufacture icon:

<https://www.istockphoto.com/vector/date-of-manufacture-icon-on-transparent-background-gm1284146169-381371878>

Pharmacy icon:

<https://www.svgrepo.com/svg/100564/pharmacy>

Home icon:

https://www.flaticon.com/free-icon/home_1946488

Lancet icon

<https://iconbros.com/icons/lancet-2>

Final design

Glucometer:

<https://www.pexels.com/photo/woman-checking-blood-sugar-with-glucometer-6303712/>