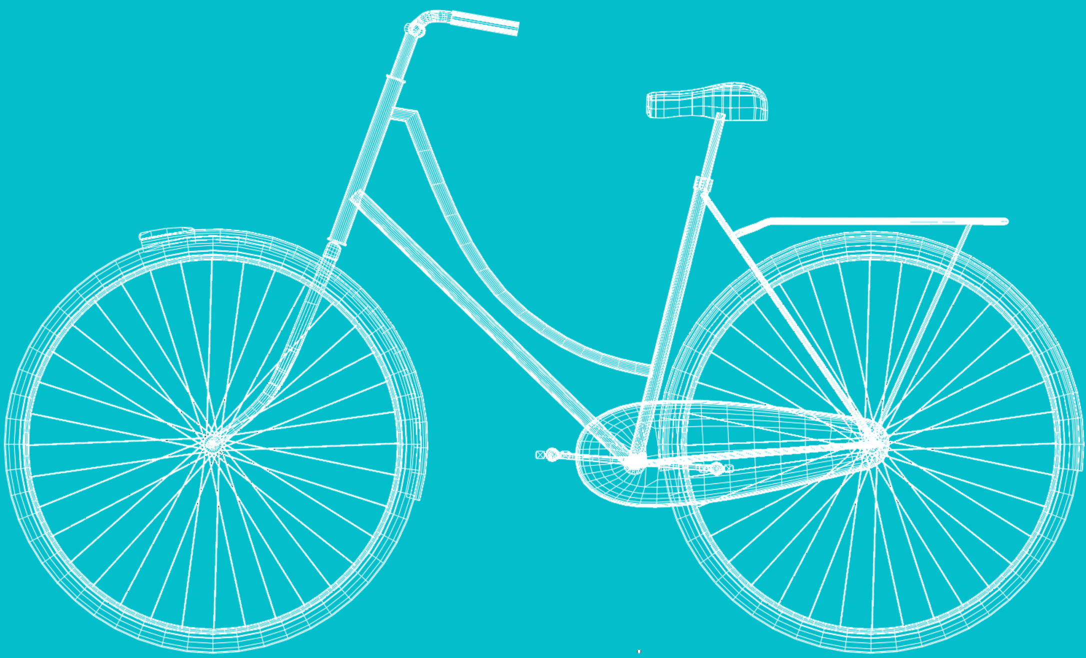


INEXPERIENCED CYCLISTS

BASTOS • BRYANT • HOWELLS • SMITH

MEET THE TEAM

LAURA BASTOS

- **Chief Operations Officer** - coordinating research strategy, logistics and timetabling
- International student new to cycling in London

AMELIA BRYANT

- **Chief Information Officer** - coordinating research data capture, insights and validation
- Driver scared of driving around cyclists

JAMES HOWELLS

- **Chief Technical Officer** - coordinating technical research, analysis and findings
- Enjoys rural cycling as a means of transport

AMY SMITH

- **Chief Creative Officer** - coordinating brand development and graphical communications
- Mountain biker but refuses to cycle in the city

IN THIS REPORT

Cycling in cities is intimidating to even the most confident of cyclists. How can we help those less inexperienced at urban cycling get out on the road? This report follows our journey through the first phase of our project. We began tackling this problem by talking to users to identify key areas of concern, critiquing existing cycling-related products, and generating a product opportunity based on these insights.

BACKGROUND RESEARCH

Cycling is extremely popular worldwide. From 2000 to 2012, the number of daily journeys made by bicycle in Greater London doubled to 580,000 – an increase partially attributed to the launch of Transport for London's cycle hire system. Despite this, cycling conditions in cities are perceived by many as impractical and unsafe[1].

With 6 cycling deaths in only two weeks in 2013[2], it's no wonder cyclists are wary of London's roads.

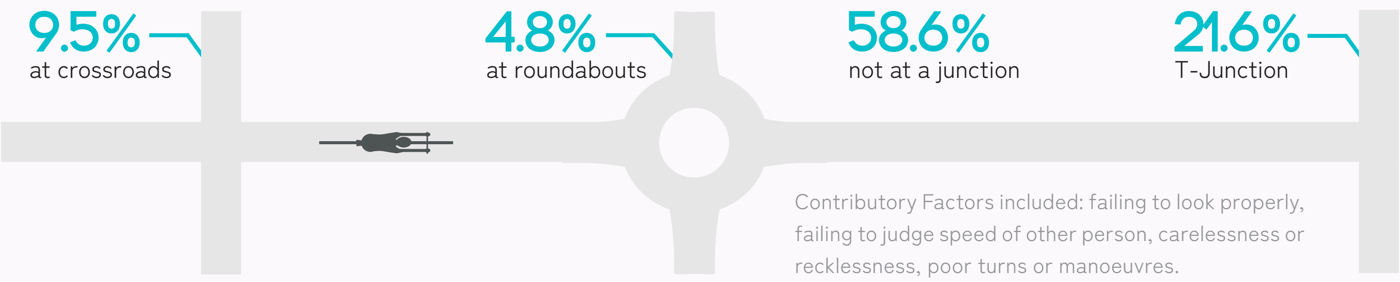
Barriers to cycling: Why don't you cycle[1]?

Despite the advantages, there are many people who choose not to cycle. The area of interest for our project is encouraging inexperienced and hesitant cyclists onto the roads.

According to the popular exercise app Strava, cycling in central London increased by 35% in February 2021, possibly due to the reduced traffic over lockdown: many took this as a time to get more comfortable with urban cycling[3].

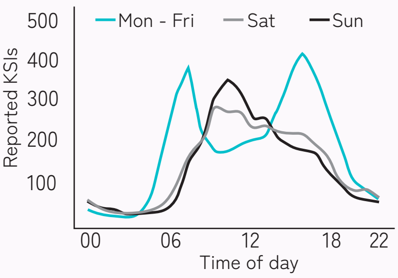
WHERE DO FATALITIES OCCUR?

According to a report by the Department of Transport for the year 2020[4], the percentage of fatal incidents for each junction type was found to be:



WHEN?

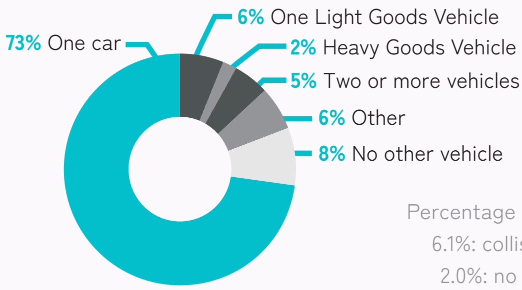
Incidents peak at roughly 8am and 5pm on weekdays, mainly due to commuting[4].



The peak for the 5pm commute may be higher due to increased tiredness along with people 'rushing' home.

WHO IS INVOLVED?

Percentage of KSIs* in collisions with . . .



*KSI: killed or seriously injured

Percentage of cyclists killed:
6.1%: collisions with HGVs,
2.0%: no vehicle involved,
1.7%: two or more vehicles involved.

We found that cyclists are acutely aware of the dangers they face, and identified key factors that contribute to risk. We will now reach out to users in order to gain better understanding of their specific needs.

USER RESEARCH I

OUR APPROACH

Our approach to user research started with the identification of pressure areas using an anonymous online survey. In the final question, we asked users who were willing to be contacted to leave their details so we could reach them for one-on-one interviews.

We interviewed eight users who made particularly insightful comments. Interviews were online: two members of the interviewing team joined a call with the participant, one taking the role of lead interviewer and the other of note-taker to make sure no insights or potential follow-up questions were missed. Calls were recorded, then insights and 'How Might We?' questions extracted.

INSIGHTFUL COMMENTS

Insightful comments, discussed more overleaf, are those that we feel are particularly relevant, either because they go into detail about points mentioned only superficially by others, or because they provide new perspectives on ideas presented by other users.

SURVEY

Quick survey sent to cyclists and non-cyclists.

ANALYSE

Data analysed and collated to find commonalities.

INVITE

Users selected and invites sent for interviews.

INTERVIEW

Individual interviews conducted online by teams of two.

RESEARCH RATIONALE

We took this two-stage (survey and interview) approach because a survey allowed greater geographical and demographic outreach than we could have achieved through interviews alone. Carefully selecting users based on the survey allowed for a much more directed collection of insights.

ONLINE SURVEY

Our survey was structured to provide the broadest possible picture of respondents' cycling habits, while still being of a manageable length so that users would finish. Questions were dependant on users' responses to previous sections:

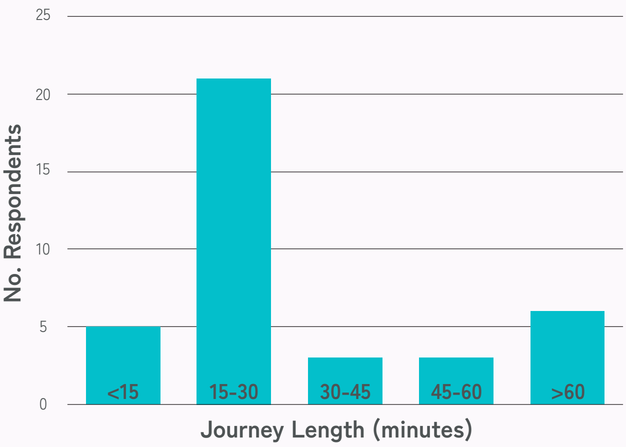
CYCLISTS → Cycling habits, influences on users' cycling, cycling skills, experience of injuries and incidents

NON-CYCLISTS → Motivations behind avoiding cycling, experience of injuries and accidents in others

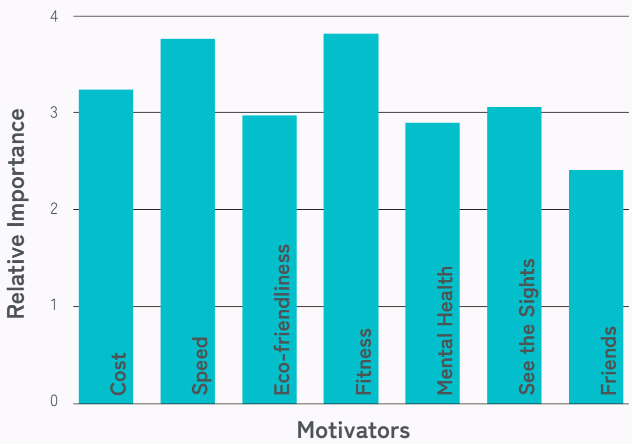
Of eighty-eight responses, twenty-nine said they did not cycle, and the remaining fifty-nine did consider themselves cyclists. We were able to use this and other responses to build a good picture of cycling habits and attitudes, and we will use this to choose respondents to interview.

USER RESEARCH II

AVERAGE JOURNEY LENGTH



REASONS TO CYCLE

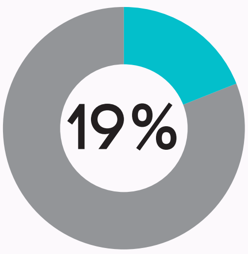


Two particularly important datasets from our survey show that average journeys are fairly short (so equipment should be easy to carry around) and users have a very wide set of motives (but speed and fitness are particularly important).

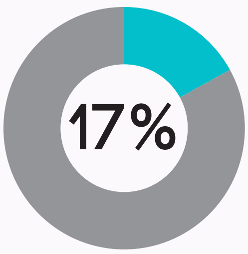
USER GROUP SELECTION

The survey allowed us to choose respondents to interview based on insightful comments they made.

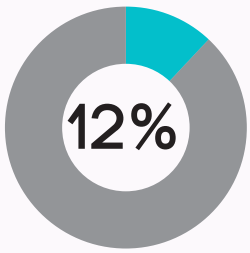
INSIGHTFUL COMMENTS



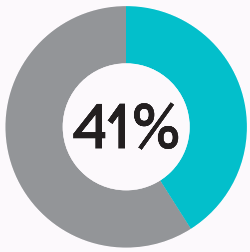
Mentioned quality of roads



Do not wear a helmet when cycling



Mentioned junctions & roundabouts



Mentioned cycle infrastructure

We selected users with different motivations in cycling (commuting, sport, fun etc.) to interview. This included ages 16 - 60, a split of genders, beginners to semi-professionals and both urban and rural cyclists. We gained insights into the dangers of different cycling styles, abilities and locations.

We also included non-cyclists to understand their motivations and the roles other road users and infrastructure play in their decisions, as well as making sure to interview international cyclists as well as UK-based ones, ensuring our product has a mass market appeal.

ETHICS

Considering the potentially sensitive nature of accident-related questions, we produced a detailed participant consent form, sent to all users before interview. We made clear that the user did not have to answer any questions they did not feel comfortable with, and the Risks section mentioned that the recollection of accidents could be traumatic.

USER RESEARCH III

PLAN & METHODOLOGY

We created interview questions around factors mentioned in the survey, such as lack of protection, dangers of cycling at night etc. A semistructured approach was taken to guide the discussion, but not limit responses. Our primary goal for the interview was to identify the specific parts of people's journeys that were dangerous, and what aspects of their experience could be improved.

RESEARCH QUESTIONS

Our focus when asking about accidents and close calls were on three main aspects:

CAUSES

- Places in the road/route
- Behaviour of road users
- Distractions
- Manoeuvres
- Road conditions

CONSEQUENCES

- Physical effect
- Emotional effect
- Behaviour change
- Purchasing equipment
- Route change

SOLUTIONS

- Safety equipment and motivations for wearing
- Locking devices
- Cycling habits
- Route planning

EXISTING PRODUCTS

We showed our users these three products to see their first impressions and to identify their needs. We then compared survey and market research results with users' interview responses.

Garmin Radar Light[5]

- **Other vehicles** worried **30% more** users than other factors
- In **1 in 4 fatal cycling accidents,** bicycles are hit from behind[8].

"I do not want to put my life in the hands of a device. For it to be useful it would have to better than my senses"

Rear Bike Signal Light[6]

- Non-cyclists were worried by having to **take their hands off the handlebars** to indicate.
- **37%** of cyclists only cycled in full daylight.

"The device is too low for cars to see, and arrows are too close together to be seen from a distance"

LED Signal Helmet[7]

- Of those who wore safety equipment, **93%** mentioned a helmet, but only **84.2%** mentioned lights.
- Accidents in the dark are more likely to be fatal[8].

"Lights may compromise the safety of the helmet, and it would be a hassle to have another thing to charge"

Users are particularly concerned by price, frequency of use, efficacy, position of controls, and how stylish it is. We will use this information to create user personas, and ensure our products fulfil user expectations.

PERSONAS

Based on our research, four clear consumer patterns emerged and were developed into personas.

Years cycling 3

Confidence

ALEX: STUDENT, 19 · YOUNG AND CONCERNED

GOALS
- Not to use overdraft
- Travel faster than other methods
- Time-efficient exercise routine

FRUSTRATIONS
- Navigating a new city
- Inconsiderate, pushy drivers
- Carrying his uni equipment

Cycling is a cheap and reliable way for Alex to travel on a student loan budget. He learnt as a child and now hires a bike as he does not have his own at university. Being in a new city with an unfamiliar road etiquette, he had a close call within his first two weeks of cycling. Knowing where to go and the stress of other road users make cycling difficult.

Years cycling 0.2

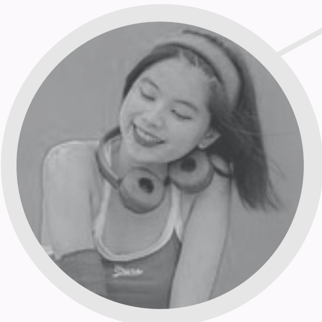
Confidence

JO: APPRENTICE, 20 · SCARED TO ENGAGE

GOALS
- Get to work on time
- Save money
- Keep fit

FRUSTRATIONS
- Feels left out from her friends
- That she feels scared
- Angry at vehicle inequality

Cycling will be good for her, saving money and keeping her fit, but after hearing how cyclists are treated she's scared she won't fit in with the aggressive city atmosphere. Jo would like to start commuting by bike but after her friend had an accident and started wearing a helmet, she was put off completely.



Years cycling 1

Confidence

ISLA: 18, STUDENT · CAREFREE AND UNAWARE

GOALS
- Be 'in' with her friends
- Look good and not carry much

FRUSTRATIONS
- Expensive, ugly equipment
- People who judge her

She wouldn't have started cycling as much as she does if it wasn't for all her friends doing the same: they like to travel together. She cycled as a child so feels confident. She knows that helmets are important, but they look bad - and she's never had an accident anyway. She often cycles home after a night out drinking as it is the cheapest and most convenient way.

Years cycling 35

Confidence

LEV: 48, HR LEAD · OLDER AND EXPERIENCED

GOALS
- Keep his family fit and safe
- Teach his children how to cycle properly

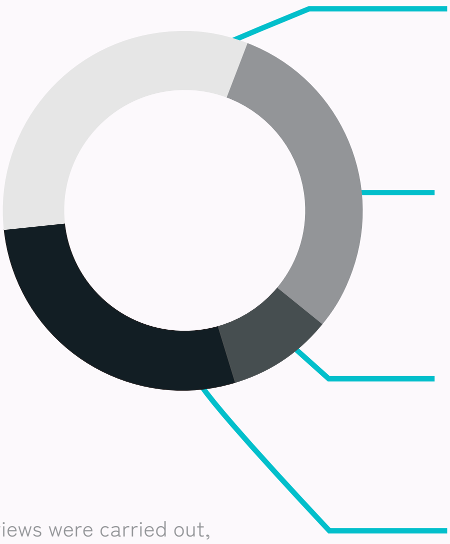
FRUSTRATIONS
- Cycling feels too risky
- New users who don't respect other cyclists

In the past, Lev cycled out of convenience but now, having a car, he does it for fun. The rules of the road have changed since he was a child; he has seen a rise in cycling popularity but also in users who do not know how to act on roads. The cycling climate has changed and he doesn't know where he stands. He has been in many crashes, so takes safety seriously.

USER INTERVIEWS

CAUSES OF ACCIDENTS

We asked our users: what happened during your accident/close call?



Interviews were carried out, answers collated and patterns and recurring themes identified. The percentages refer to the proportion of people who mentioned each category as a principle factor.

41.1% SPATIAL AWARENESS

- The majority of accidents are caused by proximity issues.
- 7/8 accidents were from rear contact, where drivers misjudged speed and could not break.

38.2% POOR INFRASTRUCTURE

- Cycling lanes exist but they have issues: they are not continuous and various cycling skill levels have to coexist
- Cars park on them, forcing bikes onto the road.

11.8% VISIBILITY

- Accidents were more likely to occur where cyclists could not see due to road layout, road position, or weather.

35.3% BAD ROAD ETIQUETTE

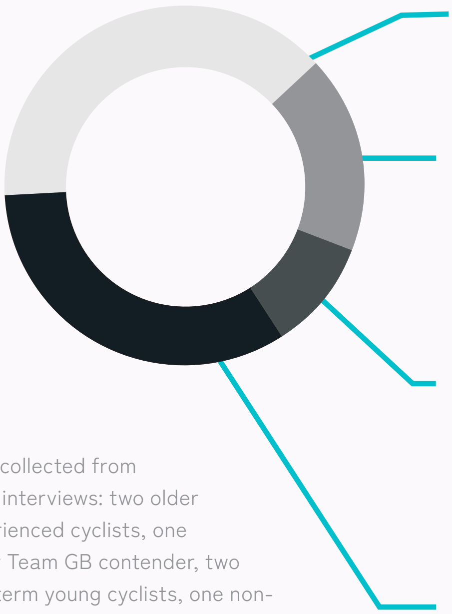
- Not abiding by the highway code, losing concentration or rushing, particularly in rush hour.
- The bad etiquette extends to cyclists as well, aggravating drivers.

“Without cycle lanes, everyone knew where they should be on the road. Now I question, ‘am I meant to be cycling here?’”

“My friend was killed and wasn’t wearing a helmet. I always wore one since then, even though I was bullied for it.”

BARRIERS TO ENTRY

We asked non-cyclists: Why don’t you cycle?



Data collected from eight interviews: two older experienced cyclists, one junior Team GB contender, two long term young cyclists, one non-cyclist, and two new cyclists. This spanned a range of genders and ages, over 4 countries, rural and urban.

58.8% OTHER VEHICLES

- The presence of other vehicles was the primary fear for non-cyclists. This is out of the individual’s control.

26.9% INCONVENIENT

- Carrying around bulky equipment all day is cumbersome and does not look good. Aesthetics trump the risk of accident.
- Equipment does not fit on hire bikes.

15.4% NOT CONFIDENT IN SKILL/NAVIGATION

- Even if they can cycle, being in the new climate is too risky, and adjusting would take too much time and risk.
- In a new city, learning new routes is hard. Visual GPS is distracting, and audio cues are not enough.

50% POOR INFRASTRUCTURE

- Though it exists, there is not enough that is of a high quality to make cycling approachable to non cyclists.

INSIGHTS

Current infrastructure makes it difficult to cycle, as people are **forced on and off the cycle paths**, and there is ambiguity about where they should be.

Accidents occur as cyclists feel that they can **weave through slow-moving traffic**. This is dangerous and aggravates drivers.

Despite cycling equipment, people know they are in constant danger: they are the **smallest, worst protected vehicle on the road.**

People generally only take routes they are certain of and **modify these to avoid dangerous manoeuvres** and junctions.

Directions from **navigation apps are communicated in a distracting way:** looking down, visual cues or audio input take attention away from the road.

Cyclists of different abilities and travelling at different speeds on the same cycle path **increases danger for inexperienced cyclists.**

Products that promote visibility are for cars to see cyclists, but do not consider the **visibility of the road for the cyclist.**

The communication between drivers and cyclists is **limited to visual,** but as there is a lot of information, these cues can be missed.

Drivers see **bikes as small and an afterthought**. This makes them feel like they have the authority, and may act aggressively towards them.

PRODUCT OPPORTUNITIES

SEPARATION | **NAVIGATION** | **COMMUNICATION**

HOW MIGHT WE...

Create a natural separation between cyclists and other road users without infrastructural changes?

Allow for increased route familiarity and city navigation without reducing awareness of surroundings?

Stop cyclists from feeling marginalised on roads while fostering communication and accident prediction?

KEY FACTORS

Battery life

Convenience of carrying equipment

Distractions such as music and phone navigation

Price of safety tech

Simple UI for intuitive control

Location such as roundabouts and intersections

Weather determines visibility

Frequency of use is the main influencer at purchase

Adaptability to personal and rental bikes

Social impressions of safety equipment

Space between cyclists, cars and pedestrians

PRODUCT OPPORTUNITY

SEPARATION

Designing a device that will aid in the separation of cyclists and other road users to improve safety and prevent accidents without infrastructural changes

Distance between large vehicles and cyclists, including buses

Dooring: the effect of opening doors on cyclists

Distance between moving cars and bicycles, especially at higher speeds

Both the **physical and perceived aspects of safety** must be considered: it must help prevent an accident and/or minimize the effects of one, and make the user feel more comfortable and **shielded on the road.**

Space reduction in slow moving traffic and bikes stuck in the middle of lanes

Rule 163 in the Highway Code requires drivers “leave at least **1.5 metres** when overtaking cyclists at speeds of up to 30mph, **and give more space when overtaking at higher speeds[9].”**

Feeling of safety without a physical barrier

Many places lack cycling infrastructure, but this **shouldn’t be a stopping factor** for people who want to cycle for pleasure, for commuting or sport.

Ensure road users know where they are meant to be

Space between cyclists, especially of mixed abilities

We will explore a range of methods to convey information in a non-distracting way, investigating the possibilities of visual, audio, and tactile communication. The product must make the user feel safe, as well as be safe.

MARKET RESEARCH

MARKET OVERVIEW

£54.44 BILLION
Global market cap of cycling and accessories[10]

7.6% PER YEAR
Average CAGR for the overall cycling category[11]

36% GROWTH
Between 2020-21 in the cycling accessories market[12]

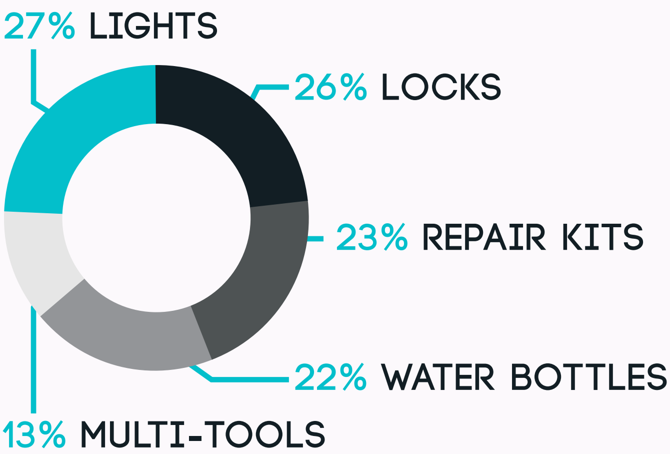
£294 MILLION
Extra spent on bike accessories than bikes in 2015[13]

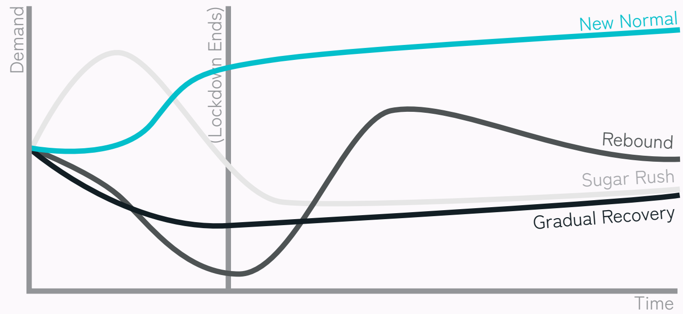
£1 BILLION
Added to the the UK cycling market during COVID-19[14]

45% MALE BUYERS
Despite males making 60% of journeys[15]

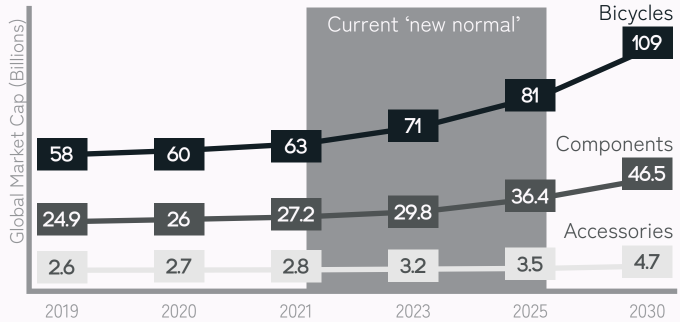
MARKET TRENDS

The proportion of all cyclists who own each respective accessory[16].





The effect of COVID-19 on the market was expected to follow one of four patterns, ultimately following the 'new normal' projection. The below graph shows the 'new normal' market projection for different sectors[11].



The likelihood a cyclist owns equipment doubles if they cycle over two days per week, as the investment makes a more tangible difference. We will be targeting this demographic as they are most likely to buy our product.

More users have invested money into cycling over lockdown, and they are not seen as a temporary peak by market analysts[11]. There are six trends that lead to high retention of these new cyclists:

KIT INVESTMENT
Government-funded programs provide incentives for healthy, sustainable vehicles.

OPEN AIR ACTIVITIES
Popular as a result of social distancing and long term gym closures.

LANE FUNDING
Over one billion € has been invested in Europe since COVID-19.

ENDURANCE SPORTS
Have had the highest participation increase throughout COVID-19.

TRENDY CYCLING
Cycling was the most positively impacted sport after COVID-19.

BIKE SHARING
Sustainable, cheaper for the public and aids in avoiding public transport.

COMPETITOR LANDSCAPE

TOP BRANDS FOR CYCLING ACCESSORIES

The top safety equipment brands target experienced cyclists. The high prices and professional aesthetic may feel intimidating for inexperienced cyclists.

BENCHMARKING ANALYSIS

Although products that aid separation are less common, we looked into three distinct areas (accident prevention, protection and relief) to identify important features. The ratings are from the customer reviews on the purchase website.

PREVENTION

On the bike
£45

See.Sense: Ace Rear Light[17]

A smart light that detects movement to save battery. At moments of risk like junctions the light shines brighter, while also acting as a brake light.

PROTECTION

On the cyclist
£166

Coros: Bone Conduction Helmet[18]

High quality headphones which don't block out external noise. Less comfortable and heavier than a normal helmet and doesn't comply with the MIPS safety standard.

RELIEF

Add on to equipment
£99

ICEdot: Crash Sensor[19]

Sensors detect a fall by measuring acceleration and forces. It sounds an alarm, and the companion app alerts emergency contacts of the crash location.

On the cyclist
£20

Lightspur: LED Foot Light[20]

Heel clamp with a bright LED visible from 700m away. However, with two hours use per day, the irreplaceable battery runs out in only two weeks.

On the cyclist
£249

Hövding: Airbag Helmet[21]

A sensor on your neck monitors movement. In an accident, the air bag inflates in 0.1 s. It is eight times more protective than a helmet, but needs to be replaced after each inflation.

On the bike
£199

Fly6: Bike Camera[22]

A dash cam for your bike, when an accident is detected recordings are saved to identify number plates. Smart video looping prevents the SD card from running out of storage.

WHERE WE WANT TO COME IN

AFFORDABILITY | SOCIAL ACCEPTANCE | SAFETY | PERCEIVED SAFETY

To make it accessible, the product must have a lower price and address social stigmas of wearing safety equipment. It must make the user **feel safe**, as well as **be safe**.

Many new products have too much technology and not enough functionality. This over-engineering can compromise safety of users. Our goal is to improve both safety and experience, so we will teardown products to see what can be improved.

PRODUCT REVIEW I

TRADITIONAL BIKE BELL

PYRAMID ASSEMBLY

All components are stacked on a central axle that is riveted (8). Components are held in place by a star circlip (4) that is held in place by the screw thread. It slides on easily in one direction, but is hard to remove. Assembly is top down - everything is dropped down onto the shaft, in a single orientation.

BUILT IN FLEXIBILITY

Component (6) houses the loose metal discs (3, 5) that hit the bell. Instead of using fasteners, the part has been moulded to have the rings slide in, with built in flexibility to allow for assembly without tools. Number of parts is minimised.

STACKED GEARS

Rotational velocity is amplified through a stacked gear (7), where the teeth on (9) mesh with the smaller gear, rotating the larger gear faster. There is nothing preventing the gears from being placed the wrong way, so the smaller gear has been made noticeably smaller.

RIVETS

(8) has a hinge that is riveted together. This permanent fixing method is lightweight and cheap, but cannot be undone.

LOCATING FEATURES, OPEN VISUAL

(1) has locating rings that allowed (8) to align, particularly as this component would be placed in blind. The visual obstruction of (1) over the rest of the components only occurs at the last step.

SPRING

Component (10) was the most fiddly and needed considerable force and precision to be installed. Position in parts (8) and (9) was not clearly indicated.

STANDARDISED BOLTS

The number of fasteners has been minimised and the only bolts used is a standard M3 machine screw, so can be assembled with universal tools. Placement is for non-restricted operation.

CORBETT DFA CRITERIA

SUCCESSES

- Minimised number of parts
- Assembly from above onto a singular base part
- Only one screw, avoids time consuming operations
- Do not need to hold parts in place while assembling

FAILURES

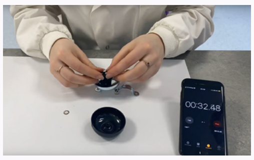
- The base is unstable due to the handlebar attachment
- Though it is 'top down', it is difficult to assemble
- The spring would tangle and is slippery, delicate and flexible, making it hard to handle
- The spring has no aligning features, placement indicators or indication of orientation
- Riveting is expensive and permanent, but may be the only viable option short of casting as a single piece. It may have been done as so to reduce expansion in casting

Time to assemble:
1:08 (without riveting)

No. components:
10

Materials:
Steel, HDPE

Manufacture processes:
Injection moulding, drawing, metal bending



PRODUCT REVIEW II

SMART TAIL LIGHT: INDICATOR AND ALARM

ASSEMBLY

Most components are installed into housings (8) and (18) from above, however, some parts are not - for example, the buzzer is permanently glued into (5). This must then be turned over and the buzzer wire connected to the PCB, housed in (8). This is time-consuming and therefore inefficient.

BUILT IN FLEXIBILITY

Snap fits have been used in several places: to connect (8) to (10), (18) to (22), and buttons (19), (25) and (27) to casing (20). In addition, a friction fit is used to join (18) to (20). This reduces assembly time by removing the need for fasteners, but makes disassembly and repair very difficult.

STANDARDISATION

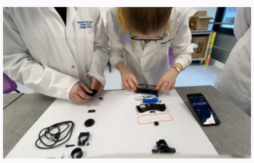
Some standard and pre-manufactured components are used throughout. For example, the main battery (4) and the console battery and charging cable (28) are standard, as are the M4 socket-headed bolts (13) and nuts (9). The four screws (6) are identical and standard. This is a good start, but more standard parts could have been used.

Time to assemble:
7:12

No. components:
37

Materials:
HDPE, Silicone, PCB, Polycarbonate

Manufacture processes:
Injection moulding, silicone casting



CORBETT DFA CRITERIA

SUCCESSES

- Parts are either symmetrical or very obviously asymmetrical
- Some standard components are used
- Parts of casing align easily and snap together
- Threaded fixings are easy to access and not obstructed

FAILURES

- Excessive number of components
- Components need to be rotated for assembly
- No locating features for gasket seals - very hard to assemble
- Handlebar clip (23) has a large gap this would be prone to tangling with other parts
- No locating features provided for main battery making it prone to adhesive-related assembly error
- Subassemblies could speed up assembly

PRODUCT IN USE

The remote holder does not fit on all bikes. The handles on Santander bikes were too wide for the holder, despite provided rubber inserts serving as an adjuster.

It was hard to attach the light to the bike as there were too many components. Two bolts, two nuts and two parts need to be transported and attached, making it fiddly and inconvenient.

The audio cues are helpful to know when the turn signal is still on, but it is not easy to use on new routes as the testers' instinct was to use hands to signal.

REVIEW CONCLUSIONS

The two products were both able to be taken apart and reconstructed. We also compared modern and traditional bike products in terms of manufacture and use.

Mechanical Steel Bell[23]

Digital Alarm and Turn Signal[24]

FUNCTIONALITY

Mechanical Steel Bell:
- Single purpose: produce noise
- Purely mechanical: lever transmits motion to gears, spinning the discs

Digital Alarm and Turn Signal:
- Multiple functions: tail light, indicator, theft alarm, buzzer, automatic brake light
- 3.7 V and coin batteries are needed

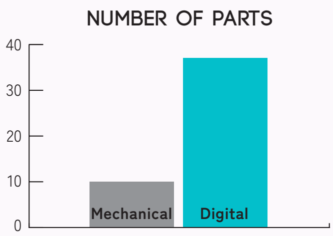
USER INTERACTION

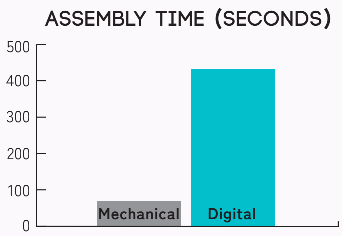
Mechanical Steel Bell:
- Actuated with the thumb, only one motion is required
- User does not need to look down
- Left and right handed versions exist

Digital Alarm and Turn Signal:
- Remote control operated, with five different buttons
- Lack of tactile features or colour distinction - buttons are hard to differentiate

DESIGN FOR ASSEMBLY

An alignment feature for the spring built into the case would reduce assembly time.

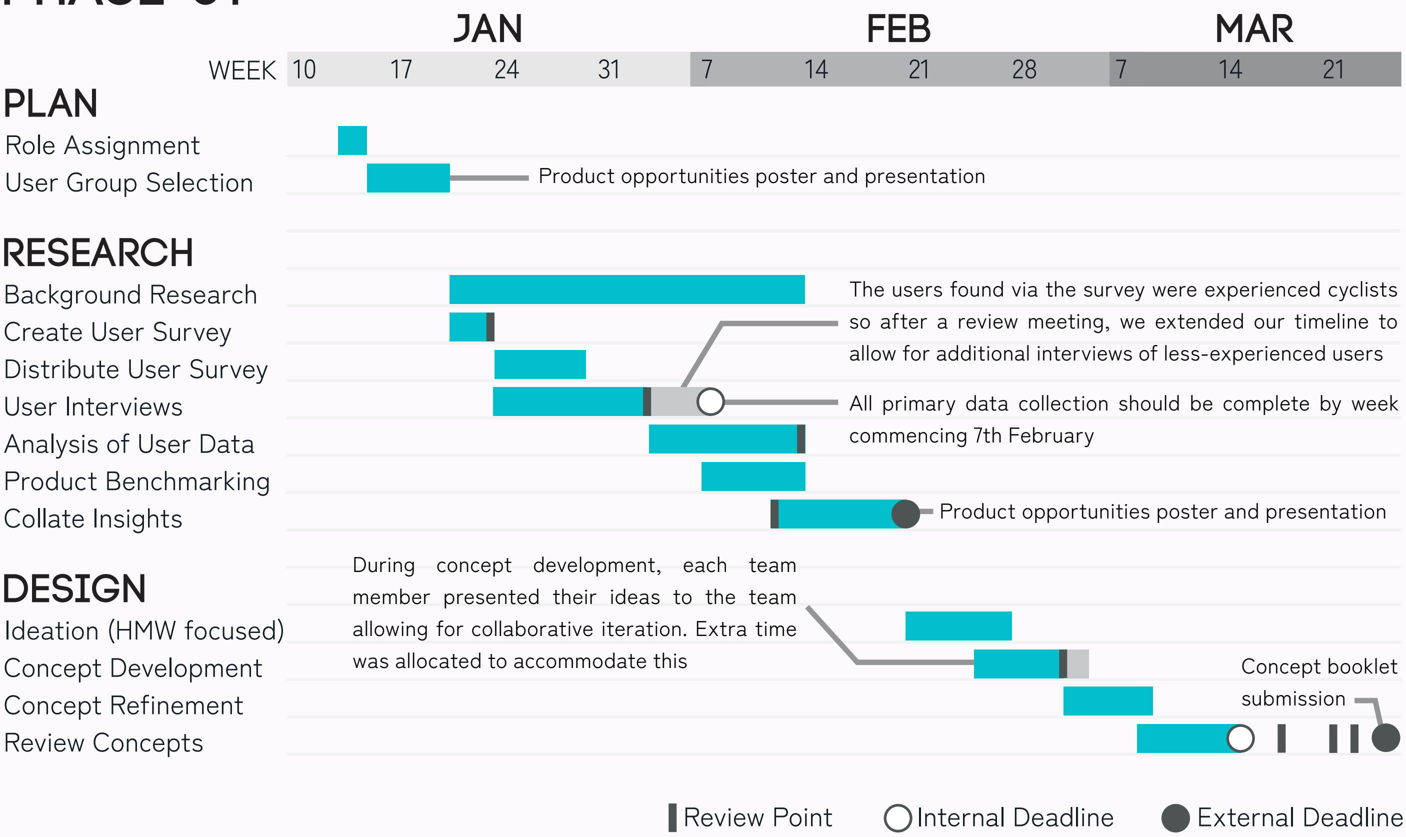




Increasing the number of snap fits would reduce the number of components.

PROJECT PLAN

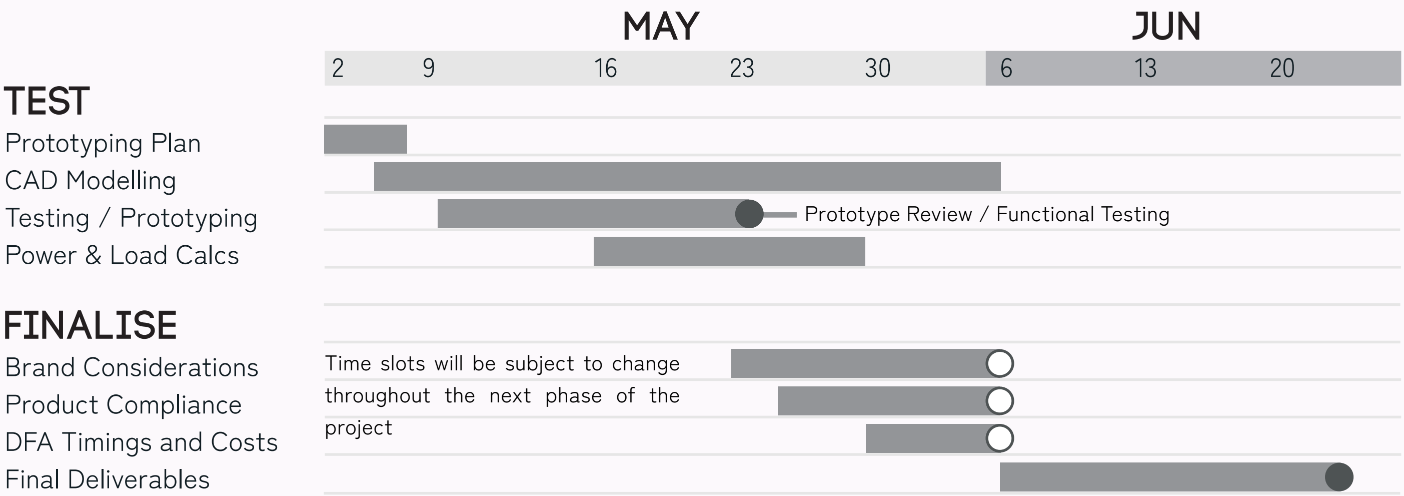
PHASE 01



This Gantt chart presents an overview of our plan for this project and highlights any revisions that were made throughout, along with the reasoning behind these revisions.

On reflection, the team stayed on track throughout Phase 01 with little deviation from the project plan shown above. The largest adjustment arose from the extension of the user interview phase as, after review, it was decided that the users chosen lacked in diversity of experience. This was quickly remedied through supplementary interviews with less experienced users.

PHASE 02



TEAM CONTRIBUTIONS

Our project plan outlines how we conducted our research and divided the workload between group members. Due to multiple revisions of the pages, we have an indicated a primary 'author', the person in charge of main content of the page, 'graphics', who helped perfect layouts and figures, and 'editors', who reviewed and corrected both content and layout.

User Research

Background

Approach and Rationale

User Group Selection

Plan and Methodology

BACKGROUND RESEARCH

- Author: Amy
- Editor: James, Amelia

USER RESEARCH I, II

- Author: James
- **Graphics:** Amy
- Editor: Amelia, Laura

USER RESEARCH III

- Author: Laura
- Editor: Amelia

USER INTERVIEWS

- Author: Amelia
- Editor: All

Market Research

Market Value and Trends

Product Opportunity

Hero Board

Key Findings and Insights

User Profiles

MARKET RESEARCH

- Author: Amelia
- Editor: James

PRODUCT OPPORTUNITY

- Author: Laura
- Editor: Amelia, James

INSIGHTS

- Author: All
- **Graphics:** Laura
- Editor: James, Amelia

PERSONAS

- Author: Amelia
- **Graphics:** Amy
- Editor: Laura

Product Review

Competitor Landscape

Products Teardown

EXISTING PRODUCTS

- Author: Laura
- Editor: Amelia

BELL

- Author: Amelia
- Editor: James

TURN SIGNAL

- Author: James
- **Graphics:** Amy
- Editor: Amelia

CONCLUSIONS

- Author: All
- **Graphics:** James, Laura

Project Plan

User Feedback

Individual Concepts

Team Contributions

Time Management

SURVEY

- Author: All
- Editor: All

ROUTEC

- Amelia

SPACELER

- Laura

EYE-Q

- Amy

OCULATE

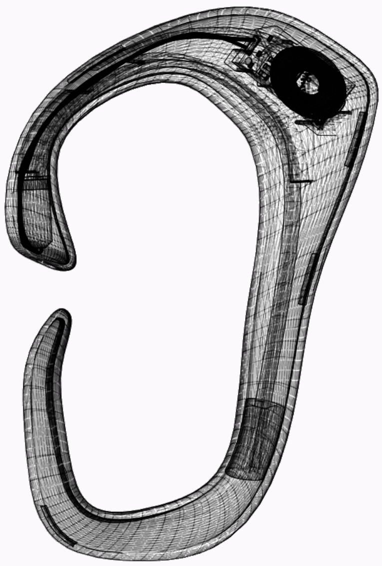
- James

TEAM MEMBERS

- Author: Laura, Amy
- Editor: Laura, Amy

GANTT CHART

- Author: Amy
- Editor: All



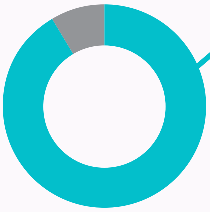
ROUTEC

AMELIA BRYANT

AMELIA BRYANT

USER RESEARCH

INSIGHTS FROM INTERVIEW



94.7% DO NOT TRUST CARS

- Cyclists believe cars do not recognise or respect them, and do not trust them to make safe decisions.

! The control must be with the cyclist, not be dependent on the driver.

71.9% HAVE MANOEUVRES THEY HATE

- Manoeuvres such as right turns and roundabouts are anxiety-inducing and increase risk. Experienced cyclists will avoid the routes involving these movements entirely.

! Inexperienced cyclists do not know ‘safer’ routes and are left on busy ones.

66.7% BELIEVE IN TECHNOLOGY

- A majority believe technology to be the future of safety, removing human decision.

! Users are receptive to digital solutions that reduce likelihood of human error.

OPPORTUNITY FINDING

‘Bells are aggressive, and create tension on the road, and they are too quiet for cars to hear’

! Communication is hostile between users - how can we make inter-user communication friendly, and recognisable to all?

‘When in a rush, you take risks to get where you need to be, have lapses in concentration’

! 80% of crashes happen at rush hour - people are uncaring and rushed. We must increase awareness and foster concentration.

‘Safety determines my route. I’m very familiar with London’s roads and know what to avoid’

! Experience is the greatest asset to have on the road. Inexperienced cyclists do not have experience, and have little time to learn.

‘I won’t use it if it doesn’t look ‘cool’ or if I can’t carry it all around’

! Beginner or experienced, appearance is the deciding factor to use, regardless of safety benefit. It has to look good.

‘If it’s a short journey I won’t wear a helmet, it’s bulky and they feel too professional’

! The product needs to be unnoticeable to passers-by, compact and transportable. If it’s easy to put on, it will be used.

‘Even though I can cycle, city roads make me nervous so I am shaky’

! The environment causes a drop in ability. The product could assist in cycling skill so focus is on the road.

Create a deterrent to others or awareness of the cyclist

Mitigate the potential for crashes to occur entirely

Aid in personal safety before or during a potential crash

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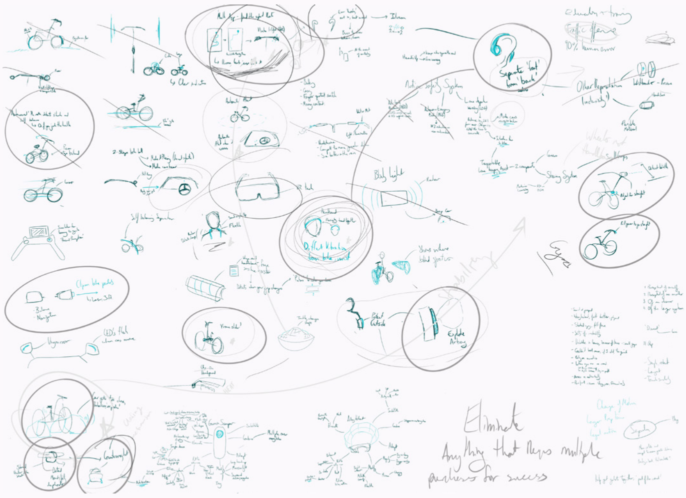
IDEATION

INITIAL IDEATION

I created 53 ideas then consulted three engineers to assess for feasibility and the concepts that they believed fit 'separation' the best. Two concepts were recurring in comments, and were made into identified metrics.



TWO RECURRING COMMENTS

PERCEIVED SAFETY

Confidence plays a large role in the behaviour of cyclists. If they feel safer, they cycle better.

SUBTLETY

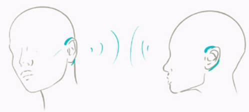
Is the concept embarrassing? If so, regardless of safety benefits, users would not engage.

DEVELOPED SKETCHES

The top 7 concepts were re-drawn, and 21 users, ranging in gender, experience and location, were asked to rank and rate the concepts. The mean rank (1 best, 7 worst) is shown.

TOGETHER CYCLE

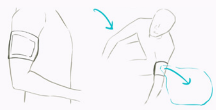
RANK 2.7



For cycling together, it alerts if you are too far apart or if a car is overtaking you.

ARM BAG

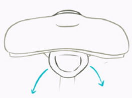
RANK 3.8



Detects falling and cushions the fall, but goes with you in case you 'fly off' the bike.

COUNTERWEIGHT

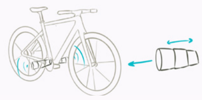
RANK 4



Counteracts movement and keeps the bike stable.

FRAME SLIDER

RANK 5



Detects close proximity and device extends to deter car. Acts as a damper if contacted.

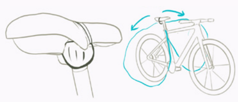
CAR ALERT

RANK 5

If the bell rings or the car is too close to bike, device inside the car alerts the driver.

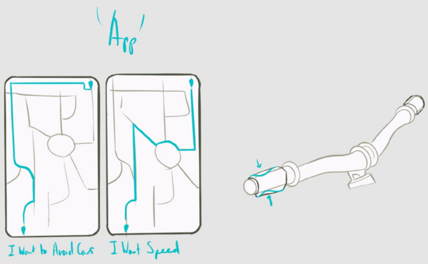
SEAT AIRBAG

RANK 5.6



If an accident occurs, airbag deploys, stabilising and cushioning the fall.

CHOSEN CONCEPT: SAFER NAVIGATION



RANK 1.4

Inputs your destination, and the app and calculates the safest route, avoiding dangerous roads, or manoeuvres (e.g. right turns). Handlebar haptics gives direction.

'This is something I would actually use'

'It would build up my confidence to learn to cycle in the city - plus I'm bad with directions'

The most popular concept for all surveyed was avoiding cars completely. This was seen as the only way to feel safe. Finding good cycling routes is hard for inexperienced cyclists, so creating a 'safe navigating' app was popular. Next I will explore feedback and sensing methods to find how to optimally direct users.

AMELIA BRYANT

NAVIGATION RESEARCH

Visual aids interfere with processing in the brain. This leads to a four-fold increase of risk of a road crash[1].

VISUAL

Looking down means surroundings are not noticed.

AUDITORY

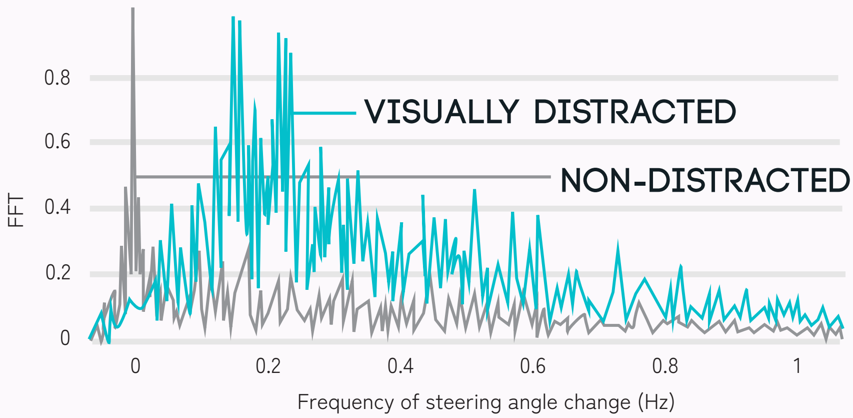
While visually processing surrounding audio is ignored.

KINAESTHETIC

For control, hands should normally be on handlebars.

MAX EFFECT

When visually distracted, the frequency of steering angle change increases in magnitude and occurrence. There is a higher deviation of steering when eyes are taken off the road[2]. Inexperienced cyclists are more unstable, making it even more dangerous.



ALTERNATE NAVIGATION SYSTEMS

Cyclists have a market for GPS that is solely based upon visuals. I looked to haptic methods to find alternate, non-visual methods of communicating with a user. The scores are their user-rated effectivness.

WAYBAND

User: Blind

Location: Upper arm

Creates a 'corridor' that vibrates to steer you away from the incorrect path[4].

YUBI NAVI

User: Blind

Location: Handheld

Twists in the desired direction. If the user needs to stop/start, the device expands[5].

SENSOVO NAVIPAL

User: Runners

Location: Waist

Eight motors on a waistband that vibrate to direct, strength based on distance to turn[6].

DESIGN GOALS

PRODUCT NEEDS

Highly intuitive to prevent errors

Positive experience to encourage repeated use

Increase actual and perceived safety via separation

Discreet look, easy to take on and off

IMPORTANCE

USER WANTS

Not rely on cars to keep them safe, be in control

Look as if they are not wearing equipment

Increase their skill and confidence on the road over time

There is a gap in the market for non-visual cycling navigation. Current tactile-based products are effective but only for low-pace, low-risk activities. They use varying vibration strengths which are hard to sense while cycling. I will do user research into the preferred interaction, product type, and placement.

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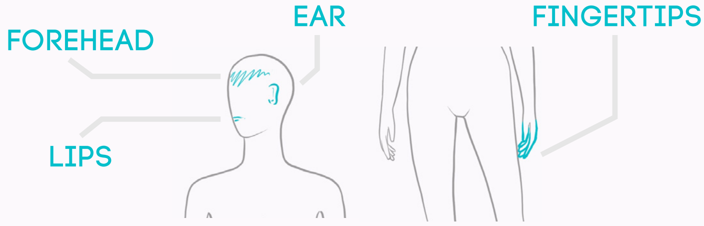
CONCEPT DEVELOPMENT

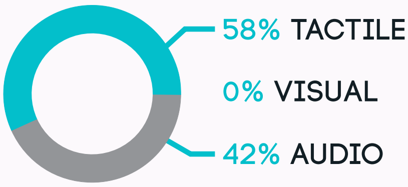
USER AND BIOLOGICAL RESEARCH

Cyclists experience many sensations while riding a bike, including vibrations on the road. It is important to assure that no sensations, therefore directions, will be missed.

The device should be on a 'sensitive area[3]' of the body to increase likelihood of recognition.

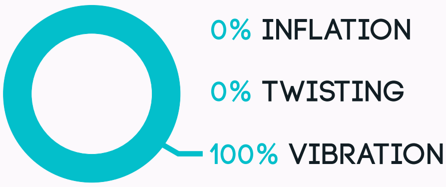


Preferred informing method



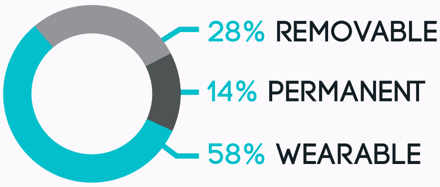
'I'd like mainly tactile, but some audio to come into play'

Preferred tactile movement



'Vibration is the only one that is good, everyone knows it'

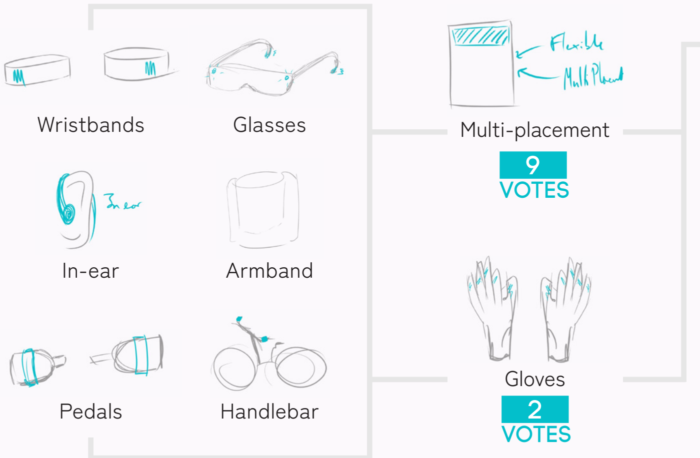
Preferred product type



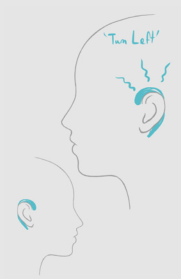
'Products that are permanently on your bike are often stolen'

FURTHER SKETCHES

With a focus on non-visual navigation, more sketches were created, and 16 users voted on their favourites.



CHOSEN CONCEPT: OUTER EARS



14
VOTES

BONE CONDUCTION
- Two devices, one on each ear, to indicate left or right turns.
- Vibration is transmitted to the corresponding inner ear.

OUTER EAR
- Leaves the ear canal open to be able to hear the road.

SMALL SIZE
- Easily transportable, quick to put on and take off.

CONCERNS

Concerns that users brought up led to design considerations and aspects to prototype.

HOW CAN I TELL THAT IT IS WORKING?

A 'start up' cue, such as light/ buzz should be incorporated into the design. **A battery check** could be put on the app.

WILL THE VIBRATIONS CAUSE TINNITUS?

Vibrations **will not cause tinnitus** more than normal headphones (used responsibly) will. Keep mechanical noise under 80 dB.

WILL IT COLLIDE WITH MY HELMET?

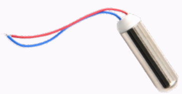
Design testing will be carried out to ensure that **no interference between helmet and earpiece** occurs.

The chosen concept uses vibration on each ear to direct the user which way to turn. Two devices are worn, one each ear, similar to headphones. Prototyping to confirm form and functionality will be carried out.

PROTOTYPING

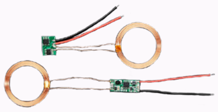
ELECTRONICS

To abide by DFA, the number of components should be minimised. As it is a wearable, size and weight should also be as low as posssible. Potential components were researched for size and price, to ensure viability.



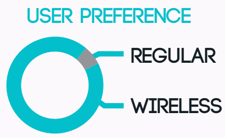
ERM VIBRATION MOTOR (£3.50)[7]

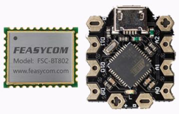
- Takes signal from microcontroller and vibrates up to 50 dB. A cylinder as opposed to disc as it would fit in the thin shape better.
- 6x12 mm



INDUCTIVE CHARGING SET (£8.70)[8]

- Wirelessly charge the device. Battery is on a chip.
- 11.4x16.1 mm, 29.9 mm diameter coil





MICROCONTROLLER (£6.88)[9] AND BLUETOOTH (£7.60)[10]

- Receive signals from app via bluetooth, drive the motor via microcontroller.
- 9.7x11.5 mm, 20x22 mm

SHAPE

Plasticine was used to test the appropriate shape of the device while using a helmet. Mock-ups of the size of the electronics were used to ensure the device would be large enough.

WHERE WILL THE ELECTRONICS BE STORED?

Interferes with the helmet strap so vibration would not be felt and it would not stay on as securely.

Fits more behind the ear but depending on position of the helmet, still contacts the strap. Would 'weigh down' the ear.

This design thickens naturally fulfilling aesthetics, and also has the most helmet strap clearance.

'This one is the most stylish design'

HOW WILL IT FIT ON THE EAR?

Clipping around the ear was the preferred method, having full round contact is safer than just 'over the top'.

In-ear section is secure but applies distracting pressure. It would also be more difficult to create a 'universally fitting' device with this feature.

A curved over-ear section is more ergonomic and feels more secure due to more touchpoints.

'I like to be able to feel it, but after a while it gets uncomfortable'

COMBINED CONCEPT

ELECTRONICS

- Microcontroller, bluetooth, charging coil all fit in upper section.

MOTOR

- Fits in slimmer section.

ERGONOMIC

- Curved to shape of the ear for max contact and vibration transmission.

SECURE

- Device is held all around the ear, externally.

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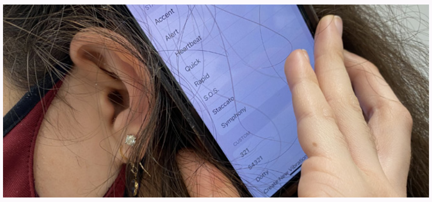
FURTHER PROTOTYPING

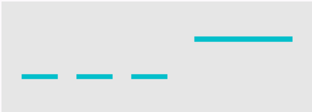
VIBRATION

The vibrations have to be noticed over the vibration of the road and factors like the cold that numb sensitivity.

Vibration patterns that would be triggered via text were created. Ten users ran (to emulate cycling pace) and were controlled remotely to test effectiveness.



3 VOTES



2 VOTES

5 VOTES

'It's better to know more in advance, so you can see and position yourself in good time'

'Long buzzes will get lost. I'd want sharp and repetitive'

'No buzz while I'm turning, it'd get distracting. I like the idea of growing intensity with proximity'

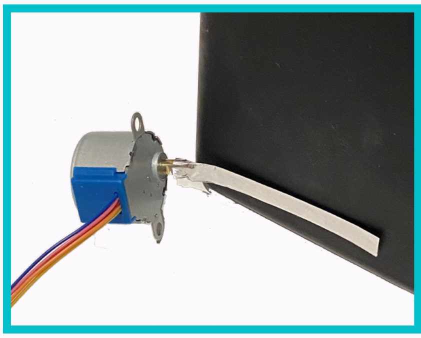
There was no clear outcome, so a new pattern, taking into account feedback, was created.

90% WERE DIRECTED CORRECTLY.

ENERGY TRANSMISSION

So that users feel the vibration all round, transmission is necessary. In prototyping, a stepper motor was used to replicate the vibration motor. Various mechanisms were held against plastic to replicate the device shell.

Gears cause a lot of chatter, and the motor did not actually move the gears at all. Ineffective at transmitting vibrations along.



A thin metal strip transmits the vibrations along the full length much more effectively. This would also be easier to implement.

CHOSEN MECHANICAL TRANSMISSION: SIMPLE BUT EFFECTIVE

CHOSEN MOTOR: ERM

ERM cylindrical motors were chosen as they have a stronger vibration profile than coin motors, are cheaper than LRA motors, and have a direct connection setup, unlike LRA which requires a specific driver[11].

Vibrations became uncontrolled. Different dampers were explored.

Easy to implement, protects both sides. Vibrations at a good level. Uses two parts, harder to assemble.

Effective at the ends, but made the centre vibrations irregular. Would be fiddly in assembly.

Slightly looser, so gave more freedom. Vibrations were at a good level. One piece and metal can 'slide in'.

CHOSEN DAMPER: OPTIMUM EFFECTIVENESS WITH MINIMISED PARTS

Subassemblies and mechanisms have been confirmed, and how users respond to the vibrations verified. Next, more prototyping will confirm how the components will fit into the device, considering assembly.

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BUILD VISUALISATION

MECHANICAL PROTOTYPE

PCB CONDENSED

- A custom PCB should be made to reduce size and component number. Cardboard was used to simulate a realistic size and shape, and a ‘cut’ in the corner was added to make it easy to tell direction to be placed into the casing, as an aligning feature.

COIL IS COMPRESSED

- The circular coil took up a lot of space. Using an ellipse improved form fitting. The change in shape would not affect its functioning.

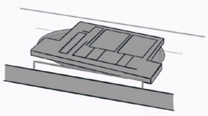
SEPARATE COMPONENTS

- Having everything loose would be dangerous, so separating ridges were created. This improves assembly as location would be clearer, and increases transmission.

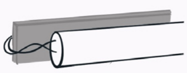
MATERIAL TESTING

- Cardboard was uncomfortable. Plasticine was added, which moulded to each users’ ears. Malleability should be incorporated by using a rigid plastic case with overmoulded shape-memory polymers to form to each user’s ears. At market, multiple sizes can be created and the SMP would personalise it for the perfect fit.

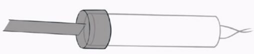
FINAL SKETCH



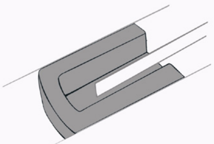
Inducting coil stacked under the electronics. It is on the ‘outside’ to ensure it interacts with the opposite coil and charges. All electronics are integrated onto one chip. The design is asymmetrical for easy assembly.



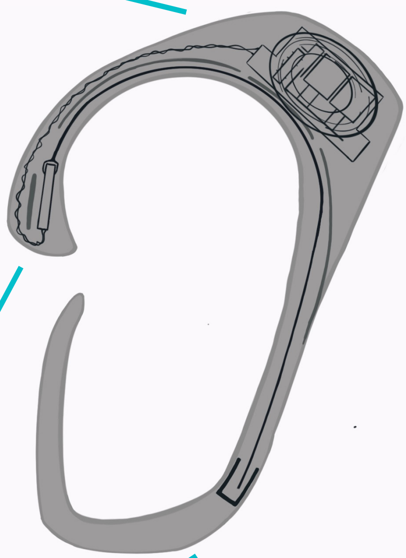
Plastic ridges separate wires/electronics from the metal band, and ensures electronics are not vibrated.



Slide-on cap easily attaches the metal strip to the vibrating motor.



Damper is symmetrical and simply ‘slides in’.



Microcontroller receives the signal from the app via bluetooth, and triggers the vibrating motor.

The respective earpiece vibrates in the set pattern - right ear for a right sided manoeuvre, and vice versa.

The metal strip is attached to this and transmits the vibration throughout the whole inner ear.

Metal contacts plastic ridges, which allow the vibrations to be felt, and is damped at the end. The ridges also separate the components.

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TECHNICALITIES

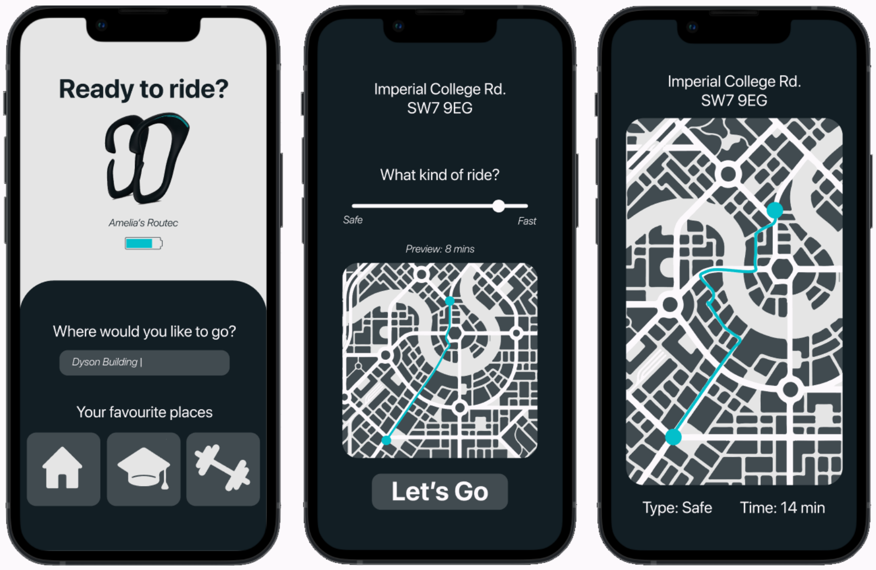
APP UI AND USER FLOW

PICK DESTINATION → CHOOSE SAFETY → START NAVIGATION → HAPTIC DEVICE

CHECK DEVICE CONNECTION AND BATTERY

ROUTE CHANGES BASED ON CHOSEN SAFETY LEVEL

SEARCH FOR DESTINATION



VIEW RIDE TIME

SAVE TOP DESTINATIONS

DEACTIVATE OTHER PHONE FUNCTIONS

COMPONENT VIABILITY

BATTERY

Inductive coil provides wireless charging with on-chip battery storage. Eliminates removing batteries, is lightweight and the eases charging process.

MATERIAL

The case is **lightweight, impact resistant ABS** to protect the mechanisms, and **soft-touch, shape-memory polyurethane** moulds it comfortably to the ear.

COMPONENT SIZE

Research indicates the concept to be feasible, maintaining the size and comfort. The shape-memory polymer would allow it **to fit a range of adult users.**

GPS

Information processing will occur in the app to minimise the processing requirements and size of the microcontroller.

TRANSMISSION

Vibration is felt all around the ear, stemming from the motor. The damper makes it have a pleasurable, not clanging, effect.

ELECTRONICS

To save space, the microcontroller, bluetooth and rechargeable battery chip would be **integrated onto one PCB.**

AMELIA BRYANT

ROUTEC

A finely engineered haptic navigation device that can be easily transported and put on, leaving your ears open to hear the world around. Though designed for cyclists, it is engineered for everyone, such as those with visual impairments.

This product can be charged wirelessly - no need for chargers or removing batteries. Simply connect to the app, set a destination and choose a safety level, and let the power of intuitive vibration guide you to wherever you wish.

APP INTEGRATION

- Choose a destination and how safe you want the route, and the device does the rest - no extra buttons.

CONVENIENT

- Battery lasts and is wirelessly charged. Small enough to be carried around with headphones, and discreet when worn.

ADAPTABLE

- Polyurethane-coated ABS gives leeway to the structure, and makes it malleable to any person’s ear.

SAFE

- Avoid cars and dangerous manoeuvres, and keep your eyes on the road with fully haptic vibration directing. Grow your confidence with gradually harder routes.

INTUITIVE

- Each ear buzzes with a simple intensity increase to indicate direction to turn. The ear is left open to be able to hear the road.

NO BUTTONS FOR INTUITIVE, EASY USE

FORMED TO YOUR EAR FOR MAXIMUM COMFORT

SLEEK, SUBTLE FINISH FOR ULTIMATE STYLE

AMELIA BRYANT

EXPLODED VIEW

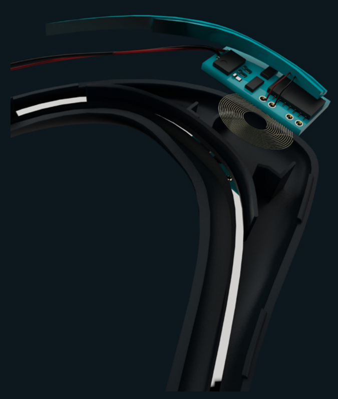
LED STRIP
- Two purposes, adding a sleekness to the design, and informing the user that the device is connected and charged.

MECHANISM
- When the vibrating motor activates, the steel strip engages, vibrates, and hits the ridges, making the whole device vibrate and resonate.

ELECTRONICS
- On-board microprocessor carries out activities, bluetooth receiver gets app signals, motor driver for the vibrating motor and chip battery to store the charge from the inducting coil.

INJECTION MOULDING
- Casing is injection moulded, with features to show where components should go. Snapfits eliminate need for time-consuming fasteners.

DAMPER
- Holds the metal strip in place and eliminates excess vibration that would get intrusive and be an uncomfortable distraction, not a useful feature.



GUIDED FEATURES FOR INTUITIVE ASSEMBLY

TOP DOWN DESIGN FOR FAST BUILD TIME

SNAPFITS FOR SEAMLESS BUT ACCESSIBLE FINISH

EYE-Q

AMY SMITH

AMY SMITH

INSIGHT SUMMARY

HOW MIGHT WE CREATE A NATURAL SEPARATION BETWEEN CYCLISTS AND OTHER ROAD USERS WITHOUT THE NEED FOR INFRASTRUCTURAL CHANGES?

To properly understand how to address this product opportunity, I reviewed the insights generated by myself and my team to highlight key factors that need to be considered throughout the ideation phase of this project. This review helped generate further How Might We? questions.

CAUSES OF COLLISIONS

Poor judgement of speed of other users

This was noted by many new cyclists: some may act too cautiously and others may act too quickly.

Failing to look properly at junctions

New cyclists are generally more "wobbly" and often said they found it hard to check properly behind them.

Poorly executed manoeuvres

Proper road placement, indication, being slow to set off are common among inexperienced cyclists.

Proximity judgement

7/8 of collisions are rear contact and new cyclists struggle to check behind. There is a clear issue here.

User Interviews

HMW improve a cyclists ability to judge the speed of other road users?
HMW give cyclists and drivers a better awareness of their distance from each other?

Though ideation will now follow the separation product opportunity, the navigation and communication opportunities should not be ignored as they are both vital in improving the urban cycling experience for new cyclists. Furthermore, they may also provide insight into alternative ways of naturally inducing separation between cyclists and other road users.

COMMUNICATION

Communication between cyclists and drivers is mostly limited to visual cues. Users are bombarded with large amounts of visual information, missing these prompts is common. Background Research

HMW improve road communication in a with visual cues in a way that doesn't distract the cyclist.

New cyclists can often get confused about proper road placement, particularly if they haven't driven a car before. This can confuse drivers and even other cyclists. User Interviews

Collisions are more likely to happen in low visibility conditions for example, at night. Moreover these incidents are more likely to be fatal. **37%** of cyclists we asked, new and experienced, only cycled in full daylight. User Interviews

HMW lessen the danger of cycling at night for new cyclists?

NAVIGATION

Inexperienced cyclists may not know the road they are travelling on well, making the experience more stressful. 35% of users we surveyed noted poor road knowledge as a key barrier to cycling. User Survey

HMW reduce the stress that comes with travelling on new roads?

Directions from navigation apps are communicated in a distracting way: looking down, visual and audio cues all take attention away from the road.
User Interviews

Users will trust their senses first, rather than a navigation app. If the directions on the app don't line up with the real world, the user's stress levels rise. User Interviews

HMW enhance the cyclists ability to navigate new areas through unobtrusive guidance?

AMY SMITH

USER JOURNEY MAP

The following user journey map was generated through asking three users that match the persona of Jo - a young person who is scared to engage - to walk me through what they have thought and felt on journeys by bike in the city.

JO: APPRENTICE, 20 · SCARED TO ENGAGE

Years cycling 0.2

Confidence

SCENARIO: Tube strikes mean Jo's new route to work is either a 40-minute packed bus ride or just a 15 minute cycle. Though cautious, she believes now is as good a time as any to try and overcome her wariness of cycling in her home city, London.

GOALS

- Get to work on time
- Save money
- Keep fit

FRUSTRATIONS

- Feels left out from her friends
- That she feels so scared
- Angry at road inequality

BEFORE THE JOURNEY

As she doesn't have a bike of her own, Jo borrows her brother's bike and helmet. She then plans her route carefully, trying her best to avoid major roads.

"People cycle to work all the time and I'm wearing a helmet!"

"I hope I remember the route I planned. I don't know how I'm meant to look at Google Maps and pay attention!"

STRESS

Key Stressor: Navigation

FEELING: Apprehensive, worried about having to deal with traffic.

STARTING THE RIDE

Nervous but as prepared as she can be, Jo sets off from her house. While she is still on familiar and quiet roads, she feels relatively confident.

"I feel okay when I confidently know where I'm going."

"It's been a while since I rode a bike, I'm still slow at junctions."

Key Stressor: setting off at junctions

FEELING: Less anxious, navigating junctions takes some getting used to.

NAVIGATING THE CITY

Jo tries her best to remember the route she planned, but finds it's not as easy as she imagined. Distracted by cars close by, she misses 3 turnings on the trip.

"I'm going to be late"

Key Stressor: cars behind

"Some cars came close behind me. I felt flustered and completely missed my turning!

FEELING: Intimidated, small, pressured like she's inconveniencing other road users.

ARRIVAL AT WORK

Jo arrives at work and parks her bike, carrying her helmet with her for the rest of the day. She feels flustered but glad she just about managed to get to work on time.

"I'm glad the tube strikes only last a few days!"

"God, I've got to cycle home again later..."

Key Stressor: overcoming her fear once again

FEELING: Relieved to get to work, feels stress of cycling is not worth it.

This generated the following HMW questions, focusing on mitigating the key stressors highlighted by users like Jo.

The HMW questions on this and the previous page will be used to inform the initial ideation process and development of concepts throughout this phase. Through discussion with users about concepts, I will also generate further HMWs.

- HMW allow the user to feel more comfortable setting off at a junction?
- HMW reduce the anxiety felt by new cyclists when dealing with traffic?
- HMW give the user better awareness of road users behind them without distraction?

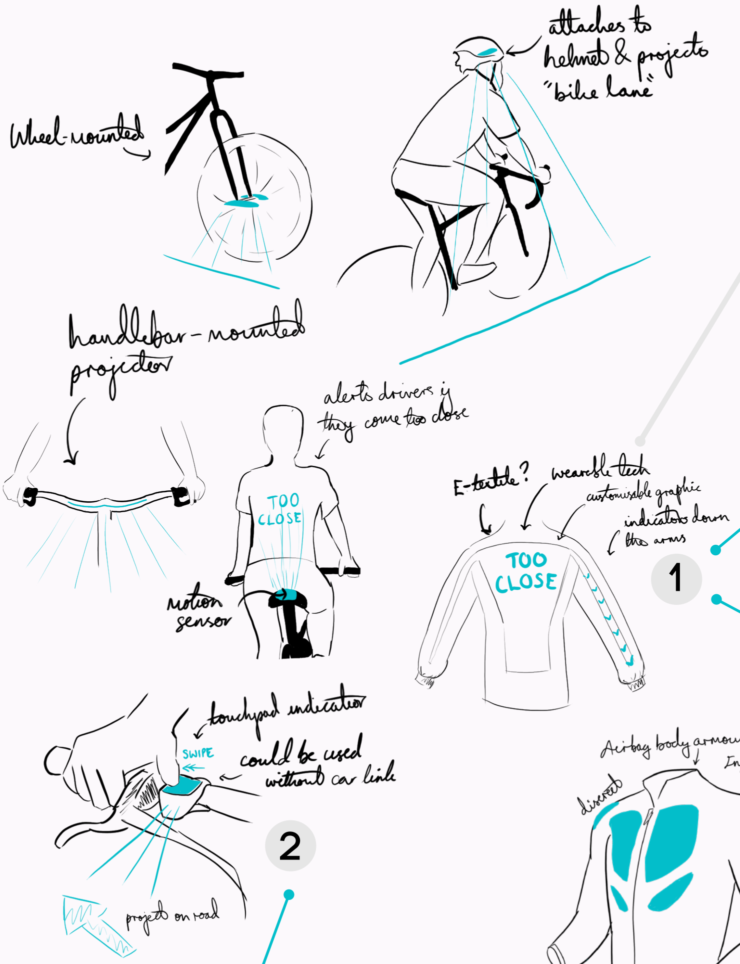
AMY SMITH

INITIAL EXPLORATION

I ideated around our selected product opportunity, allowing myself to explore different focus areas to generate a range of potential solutions. I then asked different inexperienced cyclists to select their favourite concepts and why, so I could see which have the most potential. I have highlighted the top five concepts that were favoured by users and noted some of the insightful comments made.

EXPLORING PROJECTION

Whilst the idea of a projected cycling "separation bubble" is nothing new, there are many products on the market that do just that, however these options only tend to work in low-visibility conditions. Since new cyclists will tend to prefer cycling in the day, they need something more relevant to them.



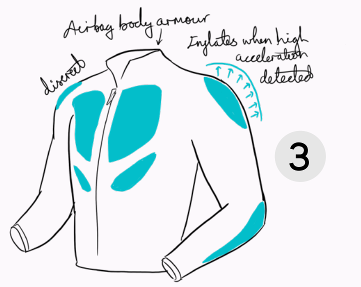
1. WEARABLE TECH

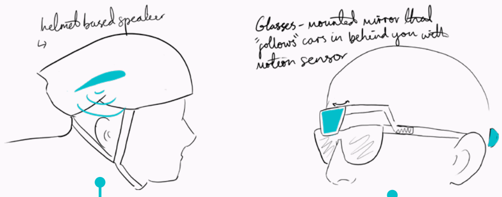
Companies like CuteCircuit have created **interactive E-textile displays.** These displays could help create discreet safety garments that could help boost the appeal of cycling to the masses. If it's stylish, people will want to be seen in it.

"I like the idea of a wearable... It'd have to be discreet though, I don't want to look like something out of sci-fi" - Lauren, 18

"The display is cool but would I have to constantly recharge whatever is powering it? And would it actually help me be safe or just distract the drivers as they go by?" - Jamie, 21

"I find it really hard to hold my arm out to indicate because I'm so unsteady... this would be useful" - Lauren, 18





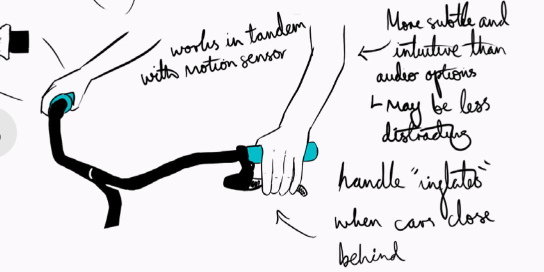
"I'm not going to wear a helmet all the time and I don't often even wear sunglasses." - Jamie 21

EXPLORING USER AWARENESS

Next, I investigated non-visual ways of alerting the cyclist to cars close behind so that even the most wobbly of inexperienced cyclists could have a strong awareness of other road users. This drew inspiration from the technology of the Garmin Varia.

NON-VISUAL AWARENESS

By using a radar sensor linked to the expansion and contraction of the grips on the handlebars, the concept could communicate instinctively when another road user is close by. It would be less distracting and more intuitive than other options on the market.



"Concept 5 is quite unobtrusive, it'd have to do a small enough inflation for me to not lose my grip. I like the fact its not trying to be the centre of my attention, my eyes and ears will still be on the road." - Jamie, 21

AMY SMITH

2D CONCEPT DEV.

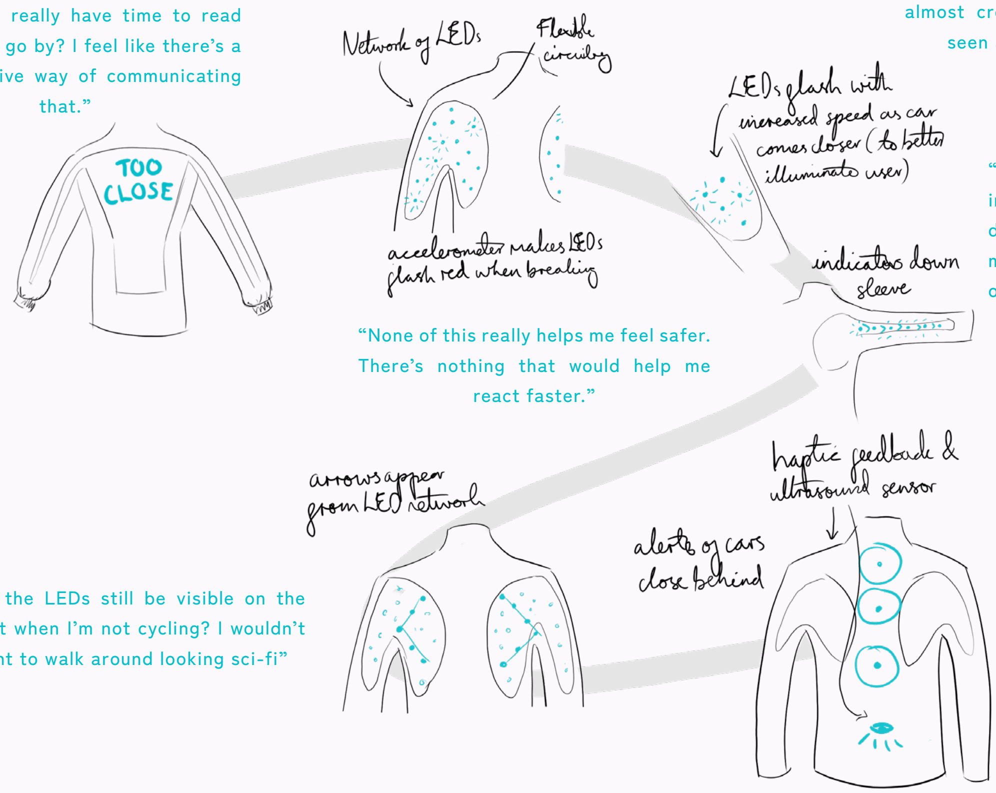
Having selected the 2 concepts with the greatest potential based on user ratings, I asked some inexperienced cyclists to sit with me while I sketched various ways the designs could be improved. They provided live feedback on the concepts allowing for rapid iteration and development directly informed by users.

CONCEPT 1

"The LED colours would have to be right, there's a reason why car signals are standardised"

"I think the random flashing lights will almost cross the line between being seen and being a distraction"

"Would cars really have time to read that as they go by? I feel like there's a more effective way of communicating that."



"I'm not sure about the indicators down the arms, I don't instantly know what that means. If were holding my arm out then sure... I'm not stable enough for that.

"None of this really helps me feel safer. There's nothing that would help me react faster."

"This is cool. If you have both the LEDs and haptic feedback then it's helping me know where cars are and helping them understand what I'm doing"

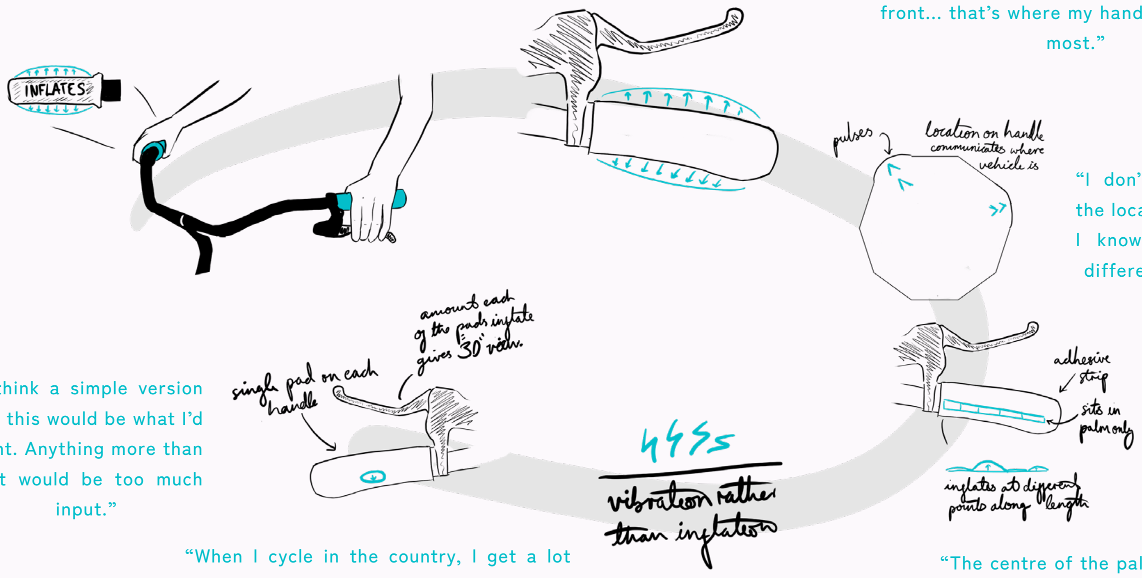
"Will the LEDs still be visible on the jacket when I'm not cycling? I wouldn't want to walk around looking sci-fi"

CONCEPT 5

"I feel like too big a change in grip size would either be really distracting or actually hurt my grip on the bike"

"The size change would have to be really gentle - I shouldn't have to adjust my grip at all"

"I like the idea of showing where the cars ... I don't think any pulses should be at the front... that's where my hands are gripping most."



"I don't know about showing the location in a line like that... I know people like to have different grips on the bike..."

"I think a simple version like this would be what I'd want. Anything more than that would be too much input."

"When I cycle in the country, I get a lot of vibrations through my hands, its the same in cities, would I be able to feel this properly?"

"I feel like too strong vibrations would put me off"

"The centre of the palm would be better so it doesn't move any of the bits that are actually gripping... I feel like that would just stress me out"

AMY SMITH

LO-FI PROTOTYPING

Following user-driven sketch development of the two concepts, my user's preferred the jacket (concept 1) and wished to proceed with this for the rest of the project. I produced some lo-fi prototypes to gain some quick insights and highlight any key issues. Each prototype was shown to my user group and their feedback helped inform further development.

HMW ensure the jacket is both discreet and comfortable enough for daily wear?

HMW ensure haptic actuators give the "3D" perspective of vehicles behind?

For the first prototype, I modelled what the wiring of the electronics would look like inside the jacket. I then gave this version to my users to try on; their feedback is noted below.

"The wires make moving my shoulders a bit tight. I don't want to feel them at all."

"For the real thing, the battery would have to be lighter and more compact - I'm conscious of it when I move."

To mitigate the feeling of "tightness", I split the wiring into two sections, using a zig-zag pattern to facilitate stretch and any movement that the garment would have to endure through everyday use. As one of my users tried on this iteration, her long hair covered the sensor - the placement is needed to be altered.

"I think the pattern of the LEDs is cool but I'd still want it to be concealed as much as possible."

"The wires feel more comfortable... I can still feel they are there though."

"The mid-back placement is good but if I were to commute I'd have a backpack with me... The sensor would just be covered. As would most of the lights."

Both the battery pack and the ultrasound sensor are now located towards the bottom hem of the jacket to avoid the weight of the battery causing discomfort or the sensor being covered by hair or backpacks.

Users also noted that they wanted the jacket to look like an ordinary jacket in everyday use so they could wear it normally as well.

HAPTIC ACTUATOR PLACEMENT

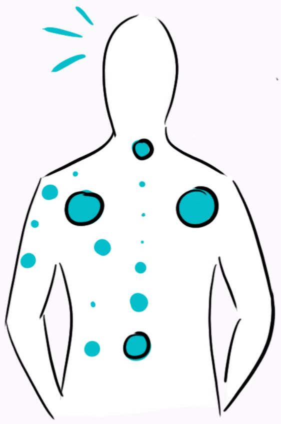
Using the vibration from my phone, I tested different potential actuator placements and asked the users to rate it's effectiveness, represented by the size of the circles shown on the map.

By using two phones, I could simulate the feedback that would be provided by the ultrasound sensor. Inspired by 3D audio, a larger vibration on one side was used to simulate a vehicle on that side.

"I think the 3D view of behind you coming from only vibrations is really cool, its like having a spidey-sense."

"I felt it most at the bottom of the jacket and the shoulder blade... it's where the fabric is closest to the skin."

"The between the shoulder placement of the buzzer wouldn't work in motion... the fabric would bunch up there and move away from my back."



AMY SMITH

CONCEPT REFINEMENT

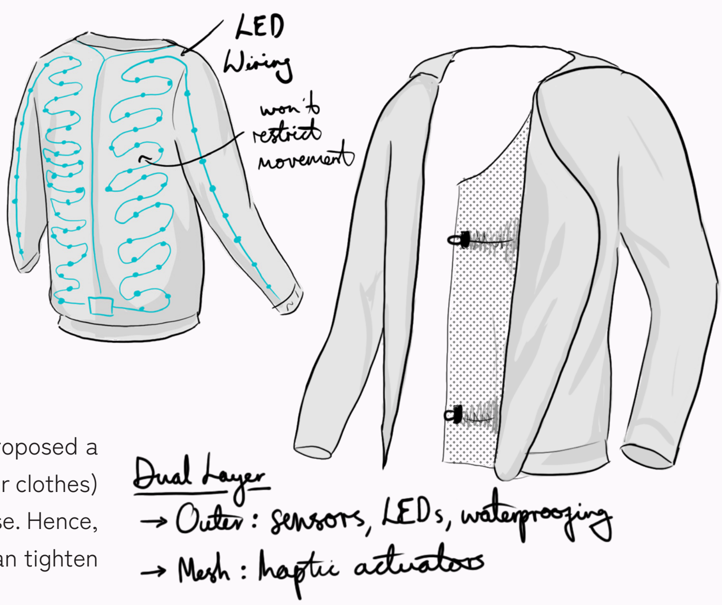
Next, I took time to incorporate the insights from previous development into the next iteration of the garment. This page details the desired functionality of the product and design considerations needed to be factored into mechanism design and form development.

REFINING HAPTIC FEEDBACK

USER NEED:
Better awareness of other road users behind them

OBSTACLES:
User comfort, clothing beneath garment

PROPOSED SOLUTION:
3D haptic perception driven by ultrasound sensor



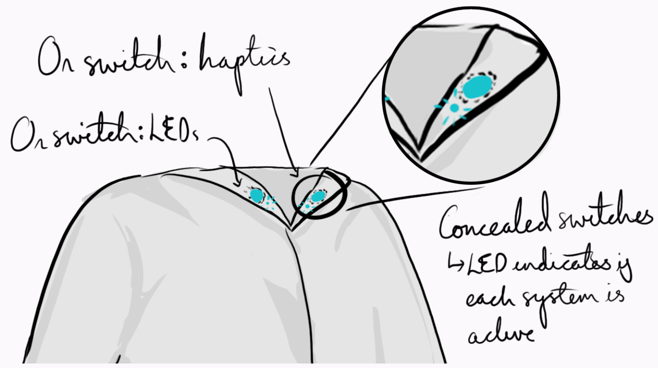
To mitigate the obstacles with the haptic feedback, I initially proposed a dual garment vest (haptics - close to skin) and jacket (LEDs - over clothes) however users felt this would be too inconvenient for everyday use. Hence, a dual layer jacket is suggested, with an inner layer that users can tighten with drawstrings to fit them correctly.

"A vest and a jacket is too much of a fuss, I'd have to remember to put on both in tandem for it to work."

"In the winter I will be wearing thick clothes underneath the jacket, maybe I could have a way to adjust the strength of the vibration it gives?"

OPERATION

HMW develop a simple UI that allows for ease of use on the go and adjustment of the strength of the haptic feedback?



Users will not want to spend ages trying to figure out how to operate the haptics or the LEDs so I have proposed a simple two button system situated in the collar. This should avoid the switches being activated or deactivated by the user's movement or by something like a backpack strap.

"I like the idea of it being simple... so many things these days are so unintuitive... I want this to be as minimal as possible"

"I think the placement is good as well, I can just turn on parts I want and set off."

FURTHER DESIGN CONSIDERATIONS & USER CONCERNS

USER DISCOMFORT:
Rigidity and placement of circuitry, bulkiness of components

STYLE:
Is this garment going to be something people will want to wear?

WEATHER:
Will the electronics survive everyday use e.g. rain, heat, cold?

REPAIRABILITY:
If a component breaks, is it easy to replace? Will replacement be costly?

CHARGING:
How long will a charge last? How convenient is the battery to recharge?

EASY OF USE:
Does the UI have a simple learning curve? Is it easy to use on the go?

AMY SMITH

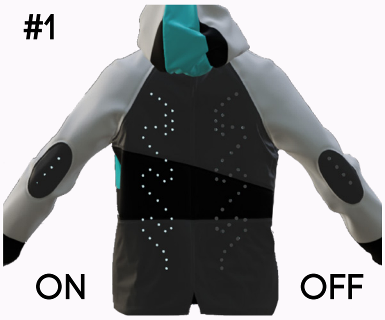
FORM & UI DEV.

Current e-textile garments often lean into their "futuristic" appeal and aesthetic. However, this makes little sense for the average person's everyday usage. As noted in a paper in 'Social Science and Medicine'[1], choice of clothing renders people on a bicycle socially visible as 'cyclists' in a way which is not true for other modes, something that has been shown to be particularly off-putting for women. Furthermore, this sentiment has been echoed in user comments throughout my own research. The form of my concept should reflect this want accordingly. The smart LEDs feature of the jacket should be subtle or not visible when not in use though must still give the cyclist adequate visibility to other road users behind.

LED PATTERN DEVELOPMENT

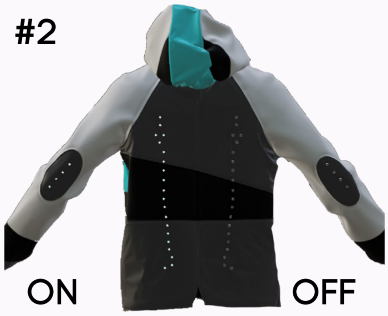
I generated 3 patterns for the LEDs on the back of the jacket and showed users what each one would look like would the LED system on and off. I then asked them to select their preferred design.

#1



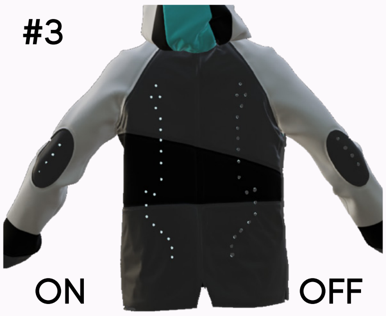
20% preferred this design

#2



20% preferred this design

#3



60% preferred this design

USER INTERFACE

Users will be interacting with the LED system and the haptic feedback system when on the move. The UI should be simple to operate so it is not adding to the distractions on the road. I asked users which button placement was easier - collar, wrist or chest.

Wrist-mounted Switch

"The cuff would have to be quite tight else it would twist when I move - especially if the switch makes it slightly heavier"

Chest-mounted Switch

"This would be easy to miss even when stationary, there's little to guide my hand to the right spot. I'd have to look down at it."

Collar-mounted Switch

"So long as the button is big enough, this should be the easiest. I like the fact it could be concealed in the collar too."

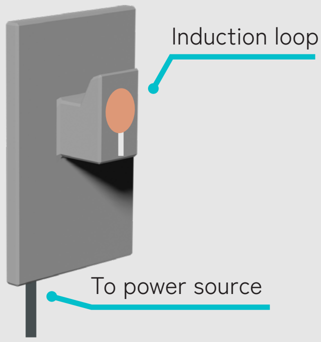
CHARGING HOOK

Throughout user interviews, charging their cycling devices was a key concern for users. It should be as convenient as possible.

Dyson Vacuum Docking station[2]

This good example of convenient charging; the vacuum is always ready to use as it is stored on the charging dock itself.

Drawing inspiration from the docking idea, I proposed the idea that the jacket could be "docked" or hung up on a hook containing a wireless charging module. Users already hang up their jackets at the end of the day, this should be convenient and easy to remember to do.



"I love this idea, it would feel very natural to do this at the end of the day."

"The shape of the hook is a bit bland, I'd want something sleeker if I'm going to have it on my wall at home"

AMY SMITH

ENGINEERING VIABILITY

The concept must be feasible with current technologies. On this page, I explore the different technologies that could be integrated into the design to ensure functionality and comfort for the user.

SOFT FIBRETRONIC CIRCUITRY

Rather than standard wiring as explored before, I researched current e-textile technologies and found fibretronics would be a more applicable solution for this concept.

WHAT IS FIBRETRONICS?
The field explores how electronic and computational functionality can be integrated into textile fibres.

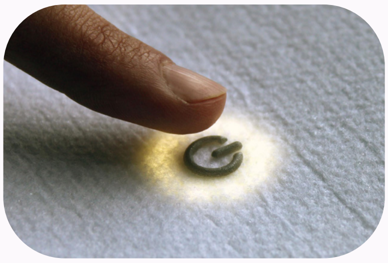
LOOMIA lighting LEL system [3] featuring flat LEDs

WHY?

Users do not want to feel the electronics, nor do they want the electronics to stand out. A fibretronic solution will allow for a simpler and more adaptive garment that moves and stretches with the user for improved comfort.

HOW?

LOOMIA Electronic Layer (LEL) is a soft circuit e-textile system that has already been used to integrate sensors, soft switches, and entirely flat LEDs into a garment. With simple waterproofing (e.g. Gore-Tex layer), this textile would be fit for use within the jacket concept.



LOOMIA soft switches for soft user interfaces

HAPTIC ENGINE

The haptic engines need to be small and non-bulky to avoid discomfort when wearing the garment (they shouldn't press into the user's back when they are wearing a backpack etc.). However, they also need to be powerful enough for the vibration to be felt through clothing.

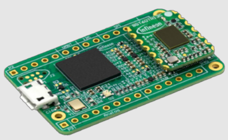
Coin Type Vibration Motor NFP-FLAT-0720-PCB[4]

- Diameter: 7mm
- Depth: 2mm

Thus, three small coin type vibration motors will be providing the haptic feedback within the jacket. Despite its size, the motor selected (shown left) has a maximum vibration speed of **10,000rpm** of amplitude **1.2G** which should realistically be felt through most clothing. It has an operating voltage range of **2.3-3.3V** which will be taken into account when powering the jacket.

SENSOR & CONTROL

Ultrasound sensors, while cheaper, are easily affected by environmental changes e.g. humidity, rain, dust[5]. Instead, a radar sensor uses radio waves which don't lose energy as they travel and can move a longer range through moist air without their performance being affected.



BGT60TR13C by Infineon [6]

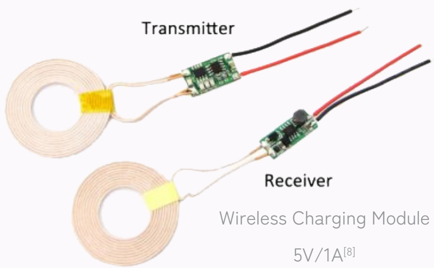
- 40 mm x 25mm
- 60GHz Radar - high resolution
- Up to 20m detection distance.
- The integrated central microcontroller unit will perform radar data processing to haptic engines

BATTERY & CHARGING

The selected battery needs to be able to power all components, be rechargeable, be easy to recharge, and must hold enough charge to last a reasonable number of trips.

Flat Rechargeable Battery[7]

- Li-polymer,
- 3.0V 650mAh
- Compatible with LEDs, selected haptic engine and sensor.
- 6mm x 30mm x 50mm - compact enough to not cause discomfort



Wireless Charging Module 5V/1A[8]

WIRELESS CHARGING

This solution is more convenient for the user as they will not have to remove the battery from the garment. Further development of the charging interaction is detailed on the following page

AMY SMITH

EYE-Q SMART JACKET

With embedded haptic feedback, Eye-Q is the smart jacket that looks out for you on the roads, providing an intuitive and non-distracting 3D perspective of anything coming your way.

AMY SMITH

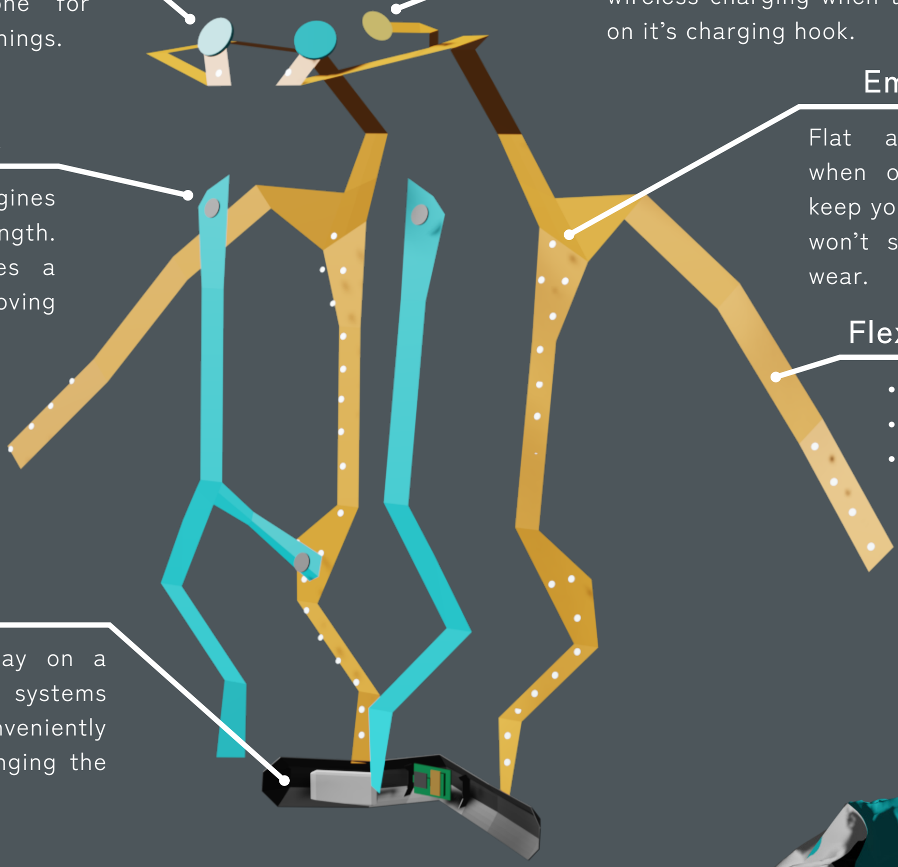
EYE-Q: HOW IT WORKS

Simple UI

One push button for activating LED system and one for activating haptic warnings.

Wireless Charging

Built in induction loop allows for convenient wireless charging when the coat is hanging on it's charging hook.



Embedded LEDs

Flat and near-invisible when off, the LEDs will keep you seen at night but won't stand out in daily wear.

Haptic Feedback

Three haptic engines vary in output strength. Their "buzz" provides a 3D perspective of moving vehicles behind.

Flexible Circuitry

- Comfortable
- Durable
- Reliable

Battery

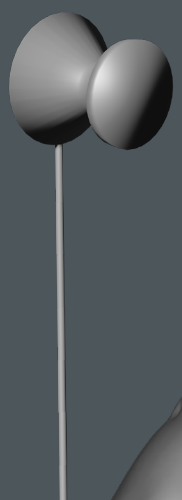
Lasting for a full day on a single charge with all systems running, it can be conveniently recharged by just hanging the jacket up.

Gore-Tex Outer

- Waterproof
- Breathable
- Durable

Convenient Charging

With a built-in induction loop, simply hang the jacket up and it'll wirelessly charge itself.

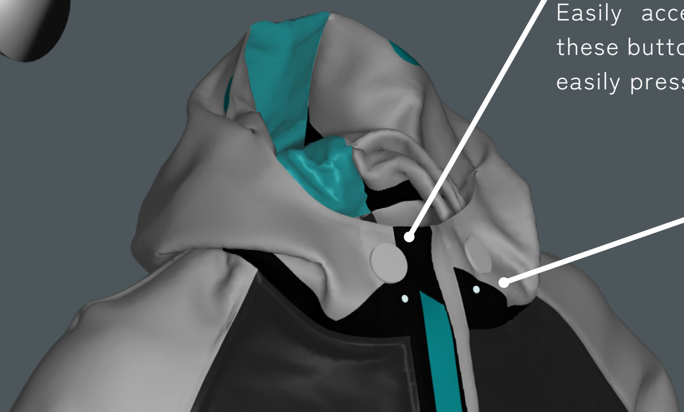


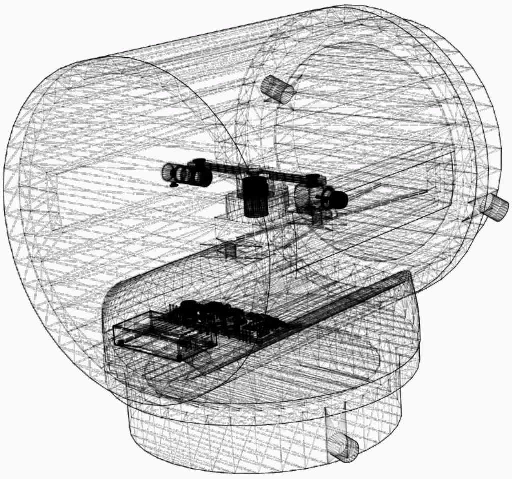
Large Buttons

Easily accessible on the collar, these buttons are large enough to easily press while cycling.

On/off indicator

Two small LEDs on the collar let you know when you've activated each system





SPACELER

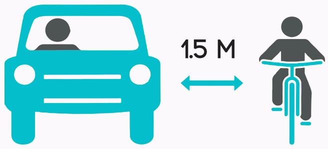
LAURA BASTOS

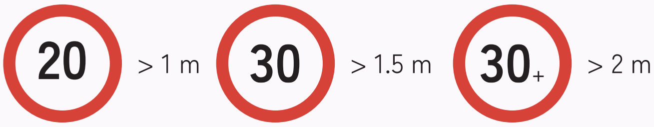
Laura Bastos

BACKGROUND RESEARCH

The number of people cycling in London has increased dramatically after lockdown, and since May 2016 the distance of cycle routes has increased by **260 KM**[1].

To further protect cyclists, The Highway Code states cars should leave 1.5 m gap when overtaking, and drivers can be fined £100 for breaching that[2].





Despite the measures in place, a study by Monash University found significant lack of space on and off cycle lanes. At speeds greater than 37 mph, **1 IN 3** passing events was a pass of less than **150 CM**[3].

Cars were actually passing **40 CM** closer on roads with cycle lanes as **"there is less of a conscious requirement for drivers to provide additional passing distance"** [3].

Cycle lanes and legislation do not protect cyclists the way they should, as the **cyclists fatalities in the UK rose by 41% in 2020**[4]. The concept aims to provide extra safety for inexperienced cyclists to feel confident on the roads.

MARKET RESEARCH

Although separation between bikes and cars is not an explicit area in the market, products exist that provide warnings and communicate where cyclists are to prevent accidents.

FOR CYCLISTS

Bikesphere
Projects a moving laser circular "shield" on the road, bikes are more visible to cars, especially at night[5].

Cyclee
Projects signs on the cyclists' back, including turn signals, according to their movements[6].

FOR DRIVERS

Honda E
Replaces side mirrors with a camera, reducing the profile, and therefore less possible areas of collision[7].

Ford Exit Warning
Sensors detect the movement of cyclists to prevent "dooring", alerts driver and locks doors[8].

CASE STUDY

"The foam pool noodle made me more visible to cars and compelled them to maintain greater distance"[9]

Michelle Robertson created a physical separation on the road by attaching a pool noodle to her bike. She said cars were suddenly giving her more space, weren't rushing past her, and were waiting for her to turn. It made her more visible while also raising awareness of the separation rules. However, other cyclists were put in danger.

KEY INSIGHTS

- Taking up more space reduced her risky behaviour, but still aggravated drivers
- It increased time taken to commute, causing cycling to be less appealing

In this project our goal is to increase separation without relying on the infrastructure. We want to do this by raising awareness, giving warnings, or providing physical protection, while keeping the user's pains and gains in mind, so I will look into their experience while cycling to gain key insights.

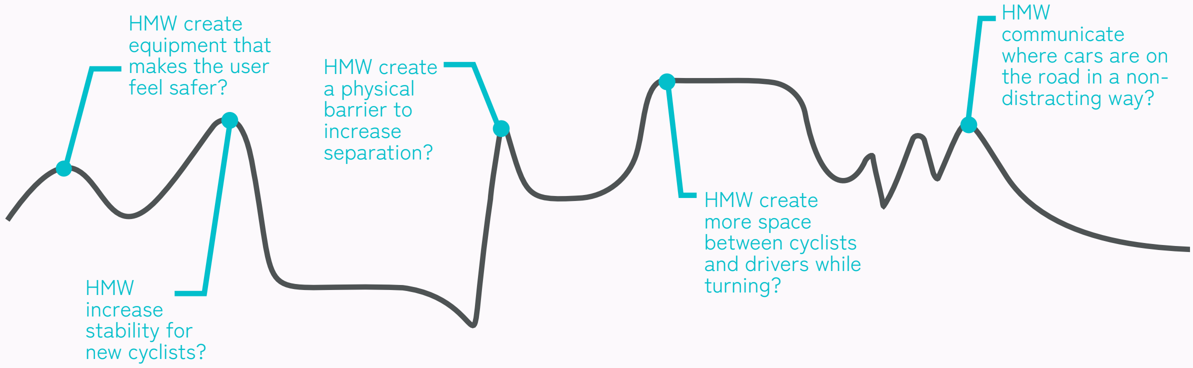
Laura Bastos

USER RESEARCH INSIGHTS

One of the users had not been cycling in a long time, and the user journey below demonstrates how her feelings changed throughout the route, and possible opportunities at different locations.

	Before		During			After
STAGE	Putting helmet on, taking bike to the road	Pushes off the bike and starts pedalling	Going on a road with cycle lane	Right turn across lanes	Narrow road with parked cars	Dropping off the bike

FEAR



DANGERS	Initial instability and worry when getting on the bike for the first time	Peripheral vision is limited, and reliance on audio cues increases	Cycle lanes without physical barriers still allows cars to get too close	Cars might be going too fast and not let you turn, causing delays in the route	Car doors opening without notice, so a distance must be kept (‘dooring’)	Sense of uneasiness that cars passed closer than allowed distance
THOUGHTS	Helmet gives impression of safety, makes her feel more confident and protected	The user feels better a few minutes in when she finds a regular rhythm	False sense of security, the bike symbol and blue lane doesn’t mean you’re safe	Ambiguous direction of cars, pulled arms closer when cars passed by	Confidence oscillates depending on recent experiences with cars	Feeling accomplished but moments where cars were too close were scary

Create physical space on the road without annoying drivers and cyclists

Aid with navigation to improve the space during manoeuvres

Predict the movement of cars so bikes can move accordingly

IDEAS FOR SEPARATION

Increase awareness of cyclists so cars can move

Increase awareness of cars so cyclists can move

Create the impression of a cycle lane on the road

Increase space right before an accident

After looking at the user’s journey and identifying the moments of most anxiety, I will ideate to solve those problems while keeping separation in mind. I will then review my ideas with users to identify which ones meet their needs.

Laura Bastos

CONCEPT DEVELOPMENT I

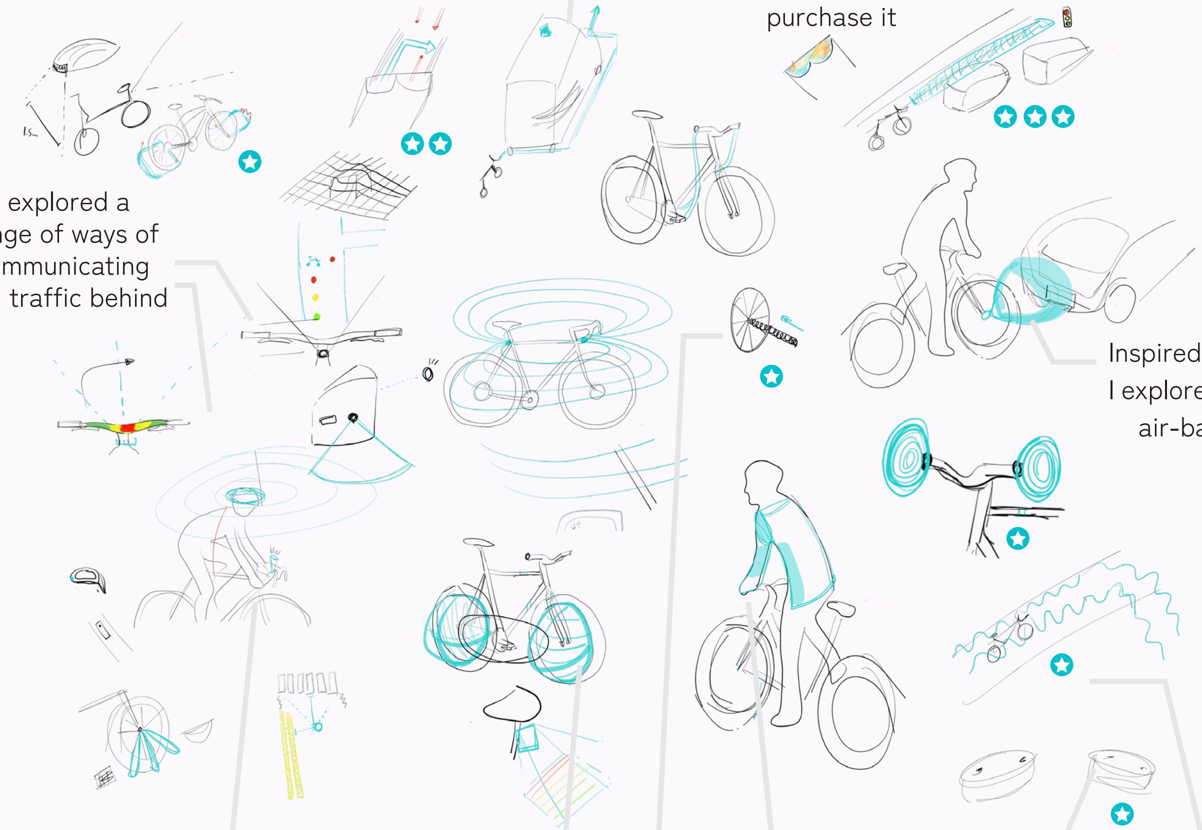
For my initial ideation, I used morphological analysis of different purposes, locations, ways of communicating and actions taken to create concepts that would aid with separation. I asked users to mark with a ★ their preferred products.

IDEATION

Devices on cars or buses have little incentive for drivers to purchase it

I explored a range of ways of communicating the traffic behind

Inspired by Hövding, I explored a range of air-bag options



Many ideas involved holograms that indicate the required space to cars by projecting a cycle lane

Protective devices to increase physical separation would make the cyclist bigger and more noticeable

Retractable parts could make the device less bulky and likely to collide

Wearables allow for more direct user interaction and convenience of removal

Navigation is an important concept as it could lead to more space between bikes and cars

After receiving feedback on these ideas, I categorised them in three main opportunities for further development, and decided to take six rated concepts forward for further improvement.

PREDICTING MOVEMENT	PREDICTING SPACE	PHYSICAL PROTECTION

HOW MIGHT WE...

Alert cyclists of the movement of cars so they have extra time to increase space?	**Measure the space between cars to aid cyclists moving through slow traffic or at traffic lights?**	**Increase space between cyclists and cars through a physical barrier?**

Laura Bastos

USER FEEDBACK

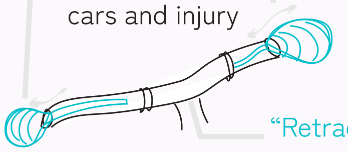
After using SCAMPER to ideate within each concept direction, I came up with new ideas for each category, and six products were taken forward for further user feedback.

1. HANDLEBAR AIRBAGS

Inflates further in case of an accident

Prevents scratches on cars and injury

Sensors cause it to inflate and deflate, alert of cars' proximity



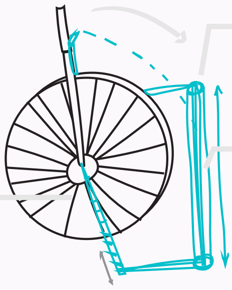
"Retract button would be useful"

FEEDBACK:

- **Air resistance** would slow cyclists down
- Difficult to **weave through traffic**
- Unwanted activation if pedestrians walk too close
- May startle and annoy drivers

2. WHEEL PROTECTION

Collapsible, extends outwards when too close to another vehicle



Front and rear collisions

Padded to act as a shock absorber

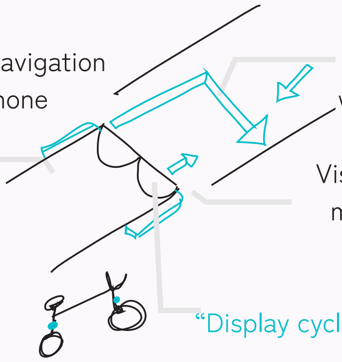
FEEDBACK:

- Needs to prevent cyclist from **tipping over**
- It would protect the wheel more than the cyclist
- Could lead to less separation and **more collisions** instead of near misses

3. CYCLING SMART GLASSES

Connects to navigation on the phone

Vibrates to indicate proximity



Indicates where to turn

Visuals indicate movement of vehicles

"Display cyclists' speed"

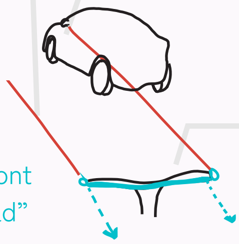
FEEDBACK:

- Making it **adjustable** would make it feel safer
- Useful to display information in front of you in a **non distracting** way
- If sensors are on the glasses it would be bulky

4. LASER SPACE DETECTION

Lasers show how much space there is

"It could be projected in front and on the road"



Avoid collision with side mirrors

Sensors measure profile of cyclist (including backpacks)

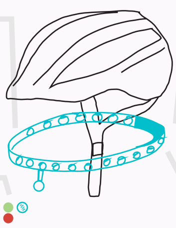
FEEDBACK:

- Automatic breaking could be built in
- **Increased spatial awareness** is an essential skill
- Must take the height of handlebars into account
- Legislation for lasers must be taken into account

5. ALL AROUND AUDIO

Band attaches to the helmet

Rear-view mirrors and proximity lights



Beeps replicate direction it is coming from

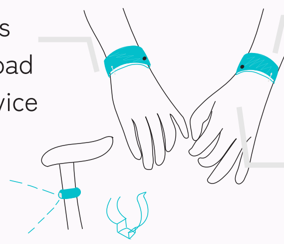
Built in sensors

FEEDBACK:

- Scared of filtered sound, still relies on it
- Beeps should be **only for specific dangers**
- Too much noise can be distracting

6. PRESSURE BRACELETS

Differentiate vibrations from the road and the device



Buzzes to indicate motion of approaching cars

"Back of the hands have higher sensitivity"

FEEDBACK:

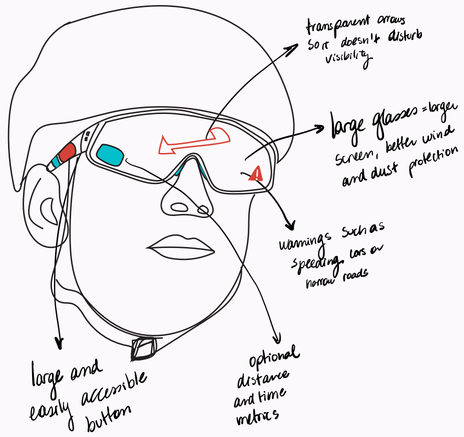
- Devices on the user are more versatile, it can be **used for rental bikes** too
- Vibrations should be **subtle** and **easy to recognise**

Laura Bastos

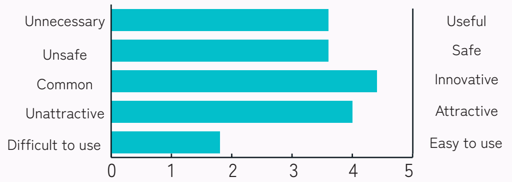
REFINED IDEAS

After considering the user feedback from the survey and interviews, the three most ideas with the best feedback were compared, and only one was taken for prototyping. The survey score refers to the sum across all categories.

3. CYCLING SMART GLASSES

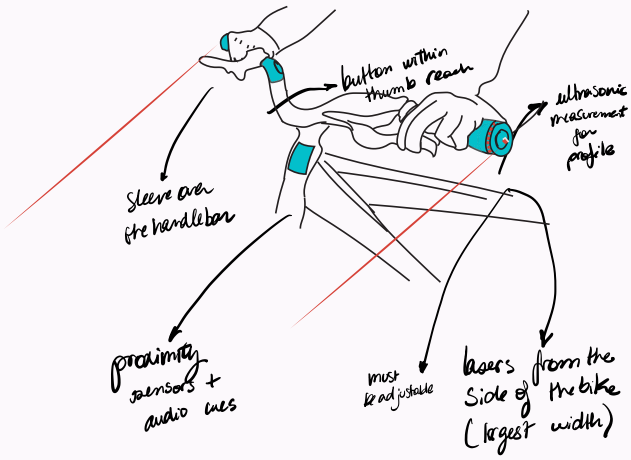


Users liked the idea of wearable devices, and in the survey it stood out in terms innovation (highest of all the products) and attractiveness. However, this idea was not taken further due to the difficulty of programming the LCD screens and predicting the movement of cars would not be possible without a powerful algorithm.

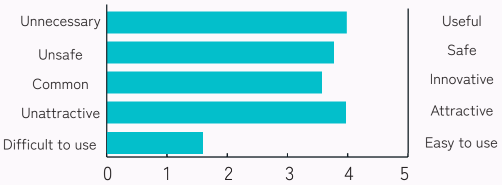


Survey score: 16.8/20

4. LASER SPACE DETECTION

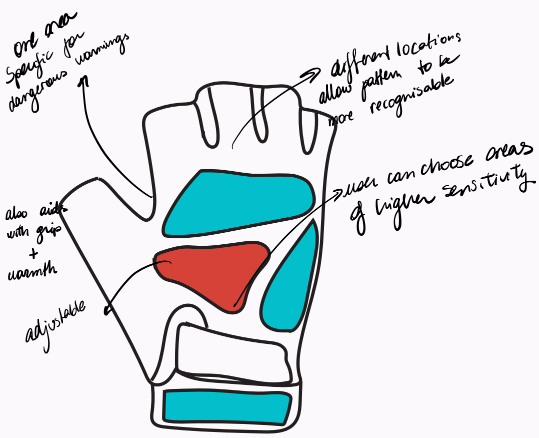


From the feedback, users believed this product had the most potential for development as current products are not found in the market. Although it was rated as more difficult to use, it will be developed to improve intuitiveness and user interaction.

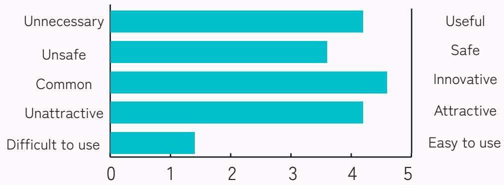


Survey score: 17.2/20

5. PRESSURE BRACELETS



I changed the device from a simple pressure bracelet to a cycling glove, which would have multiple functionalities, such as increased grip, warmth and car detection. Signalling different parts of the hand will allow the users to differentiate the pattern.



Survey score: 17.0/20

To continue the development I will only take concept 4 (laser space detection) forward. This is because of the highest relevance to the separation brief, the highest feasibility to be implemented on the roads and positive user feedback with room for improvement.

Laura Bastos

PROTOTYPING I

To further develop the laser space detection, I first decided to explore possible locations for the device while testing it on the bike with users. The main three aspects are the lasers to project the space forward, a motion sensor to measure the user's profile and a button to turn it on and off.

POSITION

Helmet: would not be possible if the user didn't have the equipment in the first place, which is often seen as embarrassing

Back of the bike: it would be useful for cars to see the cyclist, but users mentioned they liked the spatial awareness aspect so the cyclist can control the movement

Pedals: close to the ground therefore better projection, but change in angle with the rotation would make it difficult to project a path

Beside the wheels: forward projection would be convenient, but there will be too many vibrations

Side of handle bar: widest separation therefore easiest placement of laser, and correct height to measure largest width

Front of bike: easy to project, like a front light, but would be difficult to measure the user's profile

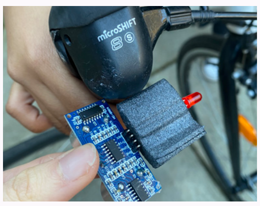
Underneath handle bar: not in the way of user's hands for those with Aero curved bars

"Depending on the type of journey or how tired I am I change my grip position"

While testing my prototype on the bike itself, I noticed how each unique handle would require a completely new configuration, and would provide a different interaction with the user. From the new observations I gathered 3 main requirements that would make it suitable:

COMPACT

Button can't take up much space on the handlebar, users may have lots of other devices like a bell or GPS.



ADAPTABLE

Some handlebars are vertical or curved, thus my product should not just be designed for straight handlebars.

FLEXIBLE

While cycling, the grip may be changed and the product should not reduce the cyclist's freedom to move their hands around.

Prototyping has been useful to better understand the scale and form of my product, as well as its positioning and user interaction. I will further prototype its position and functionality, including the laser and motion sensor mechanism.

Laura Bastos

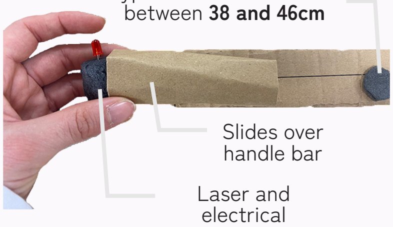
PROTOTYPING II

My main aim was to prototype a shape for the device that would suit the three main requirements while still projecting a laser path of the user's profile. In addition, users want it to be kept simple and sleek to avoid attracting attention.

FORM

SECURING ON THE HANDLEBAR

The initial idea of a cylinder sliding over the handle, would not fit on any bike due to the dimension and shape variation.



I prototyped with fabric, to keep the button and the electronic set of lasers connected via wires as one component, thus only having one set of batteries.

BUTTON REACH

I asked users to test their thumb reach and see what locations would be more convenient. This emphasized the need for adjustability as a fixed position would be difficult or annoying for many.

"I need to be able to reach it without too much effort but I don't want to press it by accident"

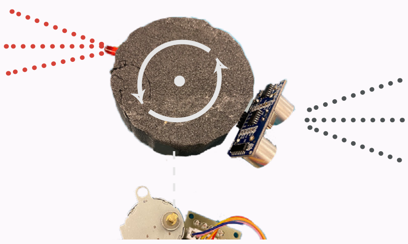
SOLUTION: separate the button from the main component and use Bluetooth to allow more flexibility.

FUNCTIONALITY

SPINNING MECHANISM

One of the most important parts of the product would be to measure the user profile and change the spacing of the laser accordingly. This would require the movement of both the ultrasonic sensor and laser.

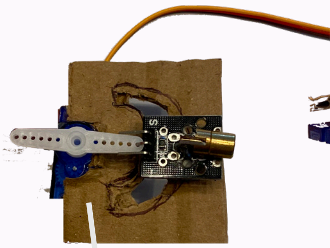
Initially I used a stepper motor and a large disk with components mounted on either side to vary the location of the laser based on the data of the dimensions of the user.



However, this turning would create a curved path, and this angled line would not be helpful for cyclists as it would not be showing their width.

"When I cycle with a skateboard on my back I never know how much space I am taking up, so this would be really useful"

I first changed the LED to a laser module, and a stepper motor to a servo motor to increase accuracy of the angle turned, then I allowed free rotation of the laser while constraining the motion in a straight line.

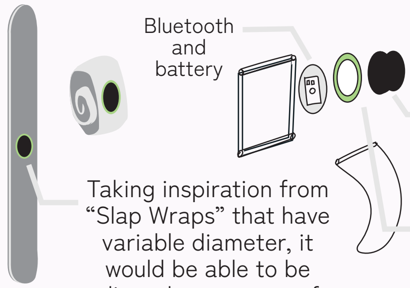


Laura Bastos

PROTOTYPING III

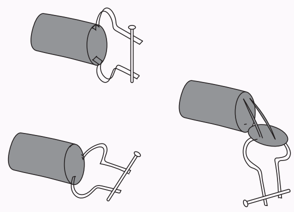
The main modifications from user feedback were easier and modifiable attachment. From the turn signal teardown, we found the clipping mechanism was not ideal as users had to hold too many nuts and bolts while assembling it. From the Garmin Varia radar light, users mentioned their expensive device felt unsecured on the bike.

BUTTON BAND

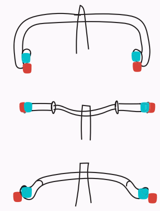


ATTACHMENT

I investigated existing screw clips to mount devices on handlebars but they would have to extend too far to fit all orientations.

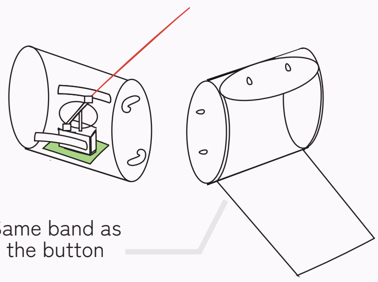


By making the main component and the way it is attached separate there is more flexibility

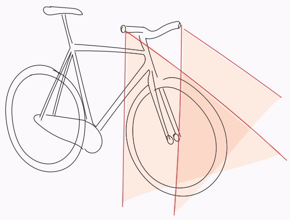


LOCKING IN MULTIPLE DIRECTIONS

The electronics compartment (with sensors, battery and circuit board) will be separate to the attachment part However they will be symmetrical, with locks in two directions.



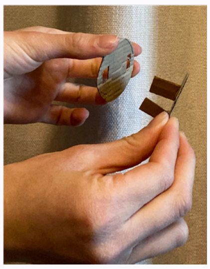
I will use an LED laser light, which shines a beam front and on the ground. It projects onto cars therefore increases visibility during the day.

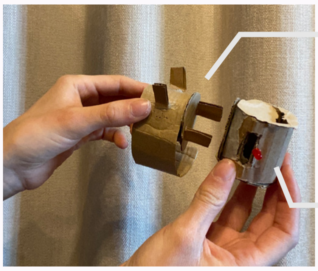


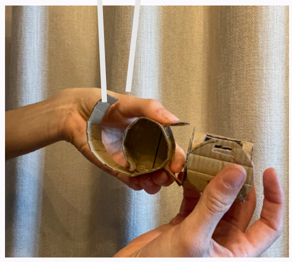
ASSEMBLY

LOCKING MECHANISM

A female and male lock will be twisted together to keep it in place. The space the locking mechanism takes up should be minimised







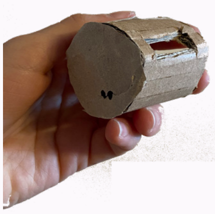
FINAL PARTS

1: BUTTON BAND

The button is important to conserve battery when not in use, and if the cyclist wants to avoid having the lasers on at all the times on cars.

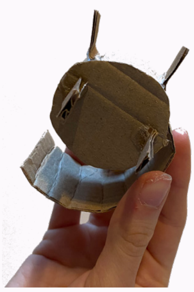
2: LASER

The main casing with the laser, sensor, servo motor and rechargeable batteries will be compact and easy to transport.



3: ATTACHMENT

The locking component will have the same overall dimensions, but the band will be flexible. It will have locks on top and on the side.



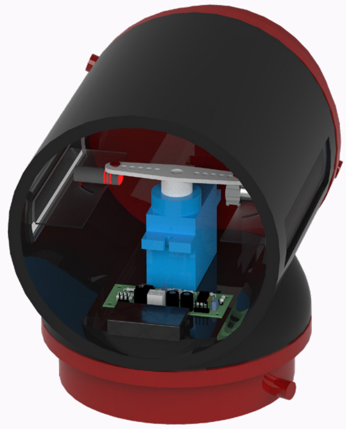
Laura Bastos

CONCEPT VISUALISATION

FINAL CONCEPT

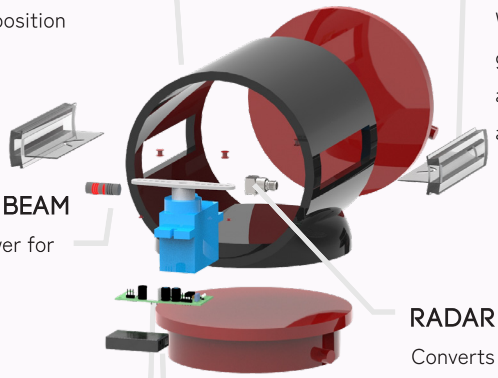
My product has three main components which are compact, and flexible to fit on any handle bar. The main components width had to be minimised to avoid taking up more space on the road.

The main casing must be kept horizontal, as the laser shines through to the path, projecting light in front (to avoid bumping into side mirrors) and on the ground. The button and the adjuster have silicone bands to adapt to the user's position.



EXPLODED VIEW

DESIGN FOR ASSEMBLY: Number of parts has been minimised, components are moulded as single parts and snap fits will be used instead of screws.



SERVO MOTOR
Precise control of angular position

ACRYLIC COVER
Waterproof seal, guides the sensors in a straight line motion and scatters the laser

ABS CASING
Injection moulded parts will reduce manufacturing time and will have alignment features to aid assembly

LASER BEAM
High power for visibility

LED STRIP
Increases visibility to make it easy to use at night

RADAR SENSOR
Converts microwave echo signals to electrical signals and measure distance to objects

CIRCUIT BOARD
Microcontroller coordinates position of servo to turn the sensor and laser. Feedback control is used to ensure correct width is projected

COIN BATTERY
Easily rechargeable from the back

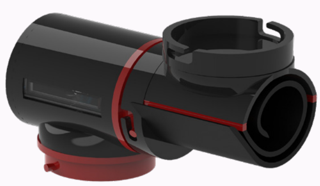
LI-ION BATTERY
Rechargeable and longer lasting battery to decrease the amount you times you have to charge

SLIDER LOCKING
Intuitive tube and slider locking, prevents it from coming undone with the bike vibrations

SILICONE BAND
Wraps around different shapes, kept in place due to friction and grip

ORIENTATIONS

Due to the two locking mechanisms, the laser can be placed at different locations based on the users' preferred hand position.



LOCKING

Bayonnet locking, used for electronics, and aerospace applications, will be used to allow easy assembly but prevent unintentional releases with vibrations. It is also fast and intuitive to put on and off the bike.

Laura Bastos

FINAL RENDER

SPACELER

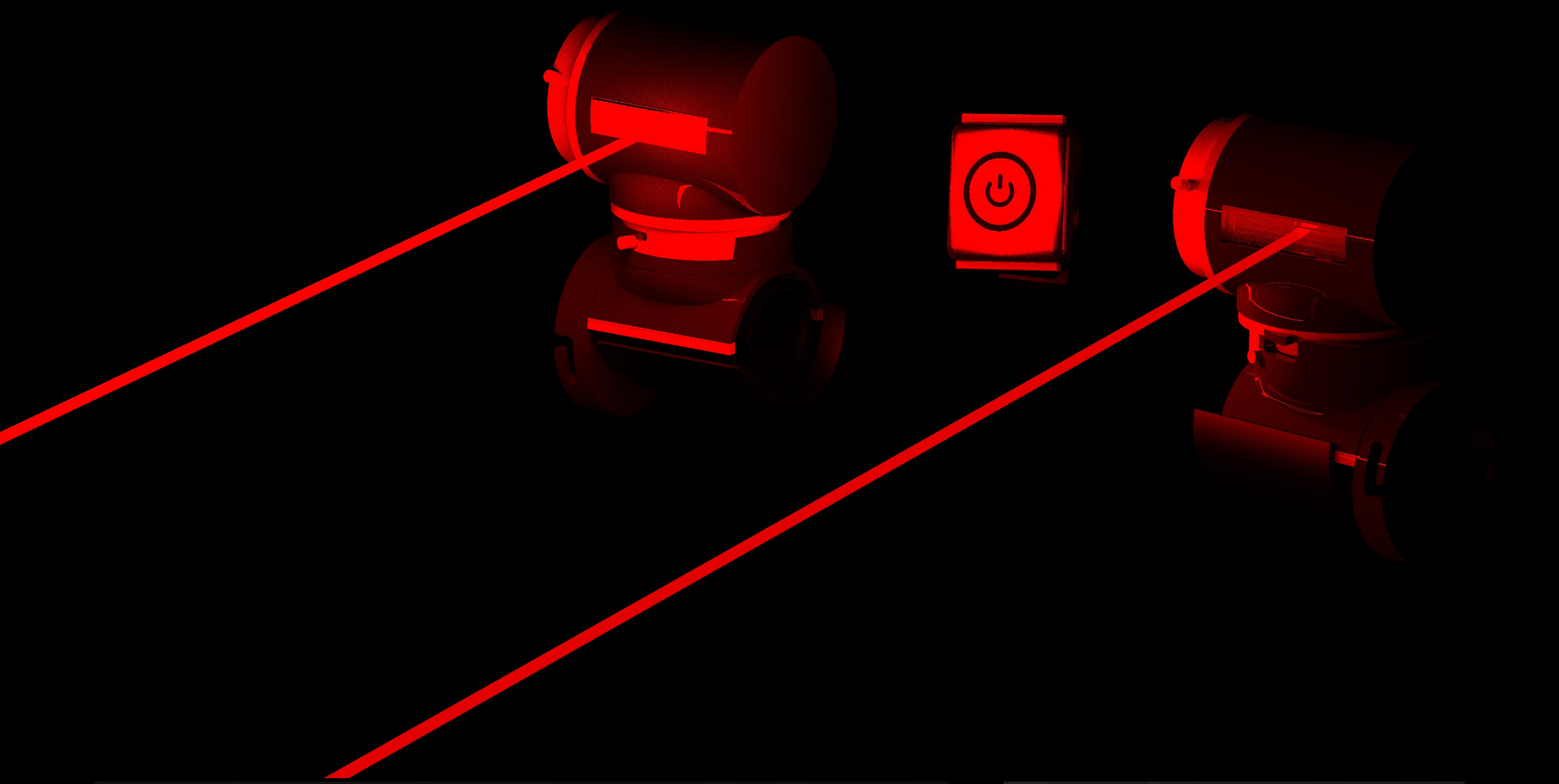
Making your journey safer with smart space detection and laser spatial awareness.

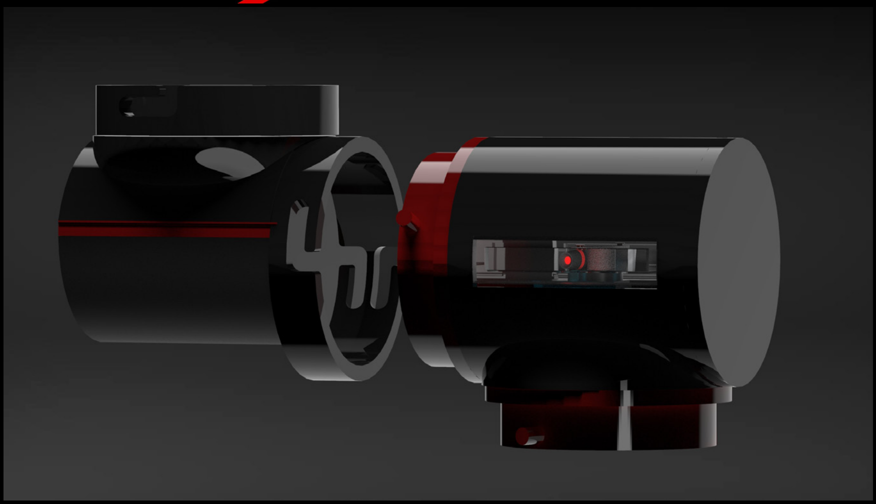
KEY AIMS:

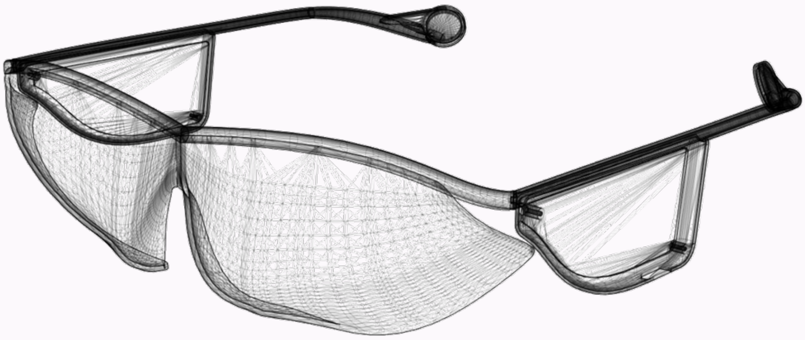
Measure the user's profile and **project their path** forward to show how much space they take up on the road, both in front and on the ground.

Aid inexperienced cyclists **weave through traffic** by increasing their span awareness, particularly if they are on new bikes or carrying backpacks.

Make a compact, flexible and adaptable device that will **fit a range of bikes** and will not disturb the cyclist's hand position.







OCULATE

JAMES HOWELLS

USER INSIGHTS

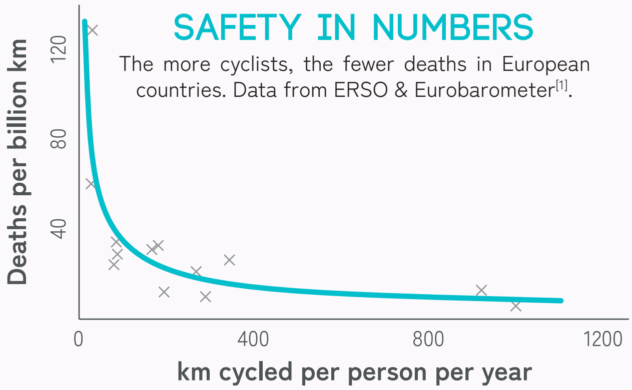
James Howells

Insights were collected from users, both in interviews and casual conversations.

"Cyclists in London don't have their own identity."

'Safety in numbers' applies to cyclists: more cyclists sticking together would make cycling safer.

A collective identity, created through branding or common products, would make cycling safer and less intimidating.



VEHICLE NOISE LEVELS[2]

EVs	40 dB
Regular Cars	80 dB
Lorries	93 dB

"Electric cars can 'sneak up' because they're quiet"

Especially at low speeds (where road noise is low), quiet vehicles pose a real threat - despite minimum-noise laws aiming to counter this.

Solutions focusing on accident avoidance should not limit users' hearing as potential hazards are already quiet.

"Horns are aggressive. We need a nice little warning."

Not only do car horns sound confrontational and aggressive, but standard bicycle bells are too quiet to be heard from inside cars.

We need better ways for road users to communicate, or to design products that cut the need for active communication.

"Navigation can take my mind off the road"

No users told us they had found good ways to navigate. Audio navigation is incomplete, and phones are vulnerable to damage.

There neeeds to be a simple way for cyclists to navigate without having to divert their attention from the road.

"Narrow roads can feel very dangerous when I cycle"

Narrow / crowded roads (users mentioned High Street Kensington) are particularly stressful.

Any means to separate cars and bikes cannot make spaces available to cyclists any smaller or narrower.

Things users said in interviews: These are verbatim quotes or abridged versions thereof.

Insights coming from their ideas: These turn users' problems into actionable points.

I will use these insights to inform a first round of ideation, before researching concepts and deciding which of them are worthy of further development.

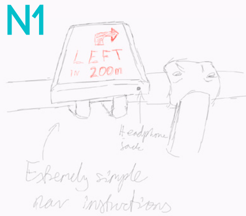
INITIAL CONCEPTS

James Howells

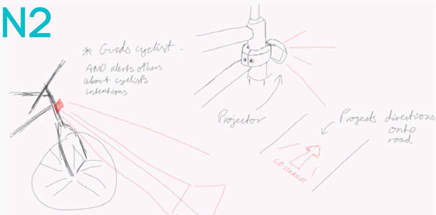
Each idea is annotated with a brief explanation and some user feedback.

NAVIGATION

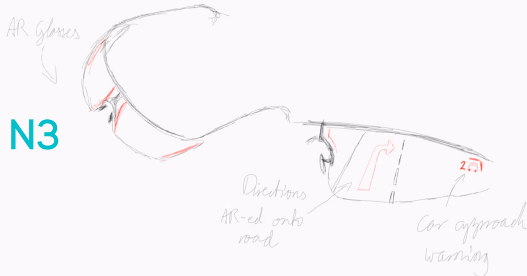
N1



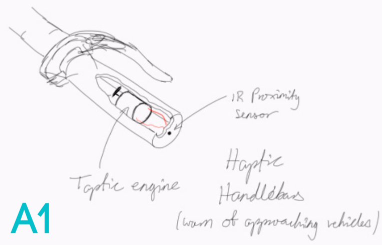
N2



N3

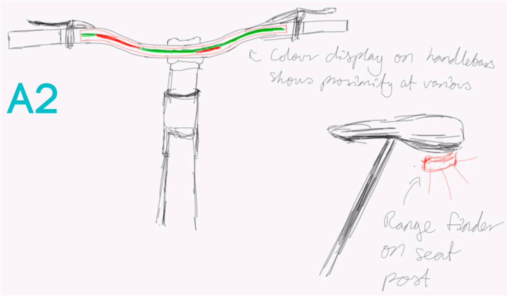


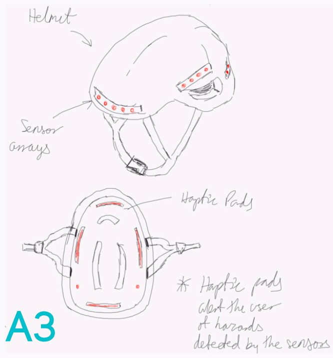
HAZARD AWARENESS



A1

A2

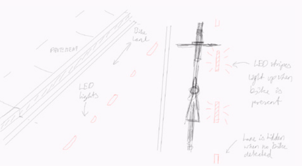




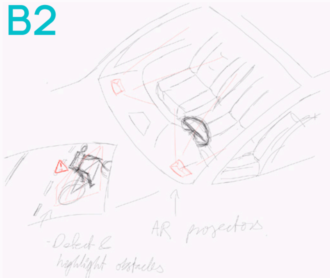
A3

BEING NOTICED

B1



B2



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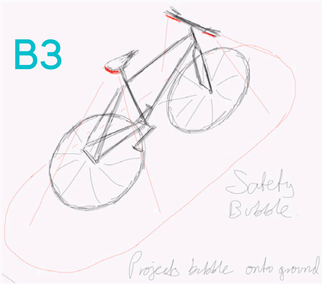
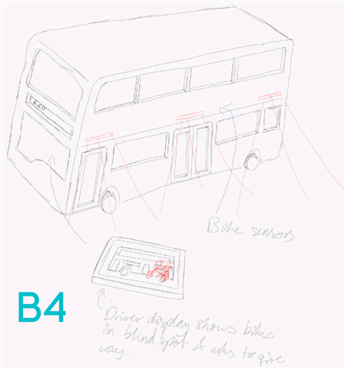
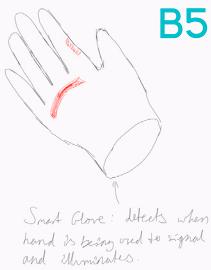
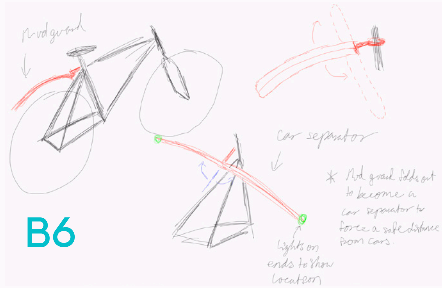




B4



B5



B6

FEEDBACK

I asked potential users for their opinions on each of these concepts. The below summary for each focuses on issues and suggestions rather than generic positive comments.

N1 ? **Simple navigation console fixed to handlebars.** Why would users choose this instead of their phones?

N2 ! **Navigation instructions projected onto road.** Would not work in the daytime: projection would not be visible.

N3 ? **Glasses display navigation and hazard information.** A good concept, but they do not necessarily need to be glasses. Could users be guided e.g. by a helmet?

A1 ! **Haptic handlebars warn of unseen hazards.** Would be useful - but would have to be permanently installed, so wouldn't work on hire bikes.

A2 ? **Handlebar LEDs warn of dangers behind.** Would require a lot of looking down - would it be any better than looking backwards?

A3 ! **Haptic pads in helmet alert of nearby hazards.** Would incentivise wearing a helmet, but doesn't tackle fundamental gripes with helmet-wearing.

B1 ! **Adaptive road markings create virtual cycle lanes.** Users may feel more confined, penned in against the kerb.

B2 ! **Projectors used to highlight cyclists.** Requires trusting drivers to spend the money on systems which don't directly protect them.

B3 ! **Creates a visual safety bubble around the bike:** As on N2, wouldn't be visible during the day. May confine cyclists, like B1.

B4 ? **Display shows bus drivers bikes in their blind spots.** Is it any better than a wing mirror? Why would bus companies pay for them?

B5 ! **Light-glove, makes hand gestures more visible:** Good idea, especially at night - but would mean yet another piece of gear to remember to charge.

B6 ? **Using mudguards to force drivers to keep distance.** How would it be deployed? Would need to be flexible so knocks don't destabilise the cyclist.

RESEARCH & INSIGHTS

James Howells

USER FEEDBACK

Based on what users said about the above ideas:

- Users would like to be able to use products on hire bikes as well as their own - products should be easy to (un)install.
- Wearables (excluding the glove - see below) are promising because of the above point: no installation is needed.
- Cyclists do not feel comfortable with solutions that rely on drivers purchasing special products, as they don't feel it is sufficiently in the drivers' interests.
- Ideas using projection achieve very cool effects - but can't cope with ambient light.

EXISTING PRODUCTS

- Higolot turn signal gloves (left) retail for £40[3]. They function exactly like the above idea (B5).
- Laser lanes (right) are available from many companies (including Halfords[4]). There is little potential to develop B3 further.

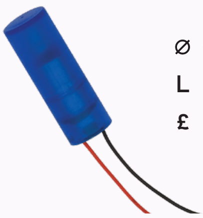
ENGINEERING VIABILITY

As many of my concepts rely on electronics, I have investigated availability of small-scale electronics to run the products:

HAPTICS

Many of my concepts feature haptics. Luckily, vibration motors come in many shapes and sizes:

Capsule Type



Ø 0.88mm
L 24.9mm
£ 6.47[5]

Disc Type

Ø 10mm
L 2mm
£ 1.12[6]

Rectangular motors, like those used in phones, also exist - but they tend to be bulkier.

BATTERIES

Size of the batteries is key. For sustainability, recharging is better than replacement.

L 20mm
W 25mm
T 3.0mm

Mini-batteries are cheaply available - this one has a 200 mAh capacity, which is relatively high.[11]

GENERAL COMPONENTS

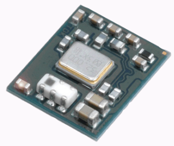
There are a few basic components that most electronic solutions will need:

Processor

L 26mm
W 18mm
H 3.0mm

ESP32 processor - with WiFi and Bluetooth built in.[7]

Bluetooth



L 4.6mm
W 5.6mm
H 1.0mm

SESUB-PAN-T2541 - the smallest bluetooth module available.[9]

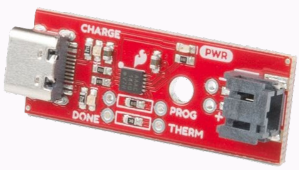
Sensors

There are many options for proximity sensing:

SR04 ultrasonic sensors are cheap and easy to use.[10]

Infrared sensors are smaller - but more expensive.[8]

Li-Po

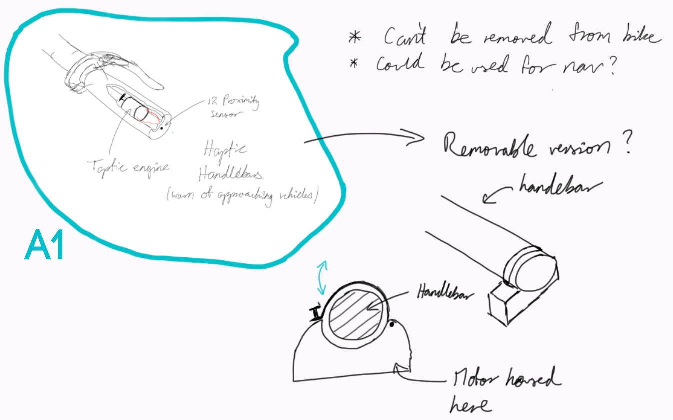


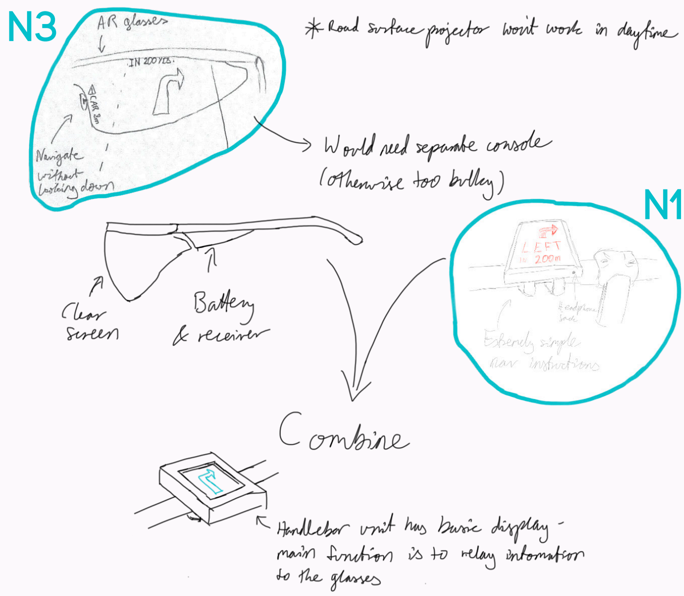
The battery (left) is a lithium polymer (Li-Po) battery, which need special charge controllers like this SparkFun[12] one to maximise battery lifespan and safety.

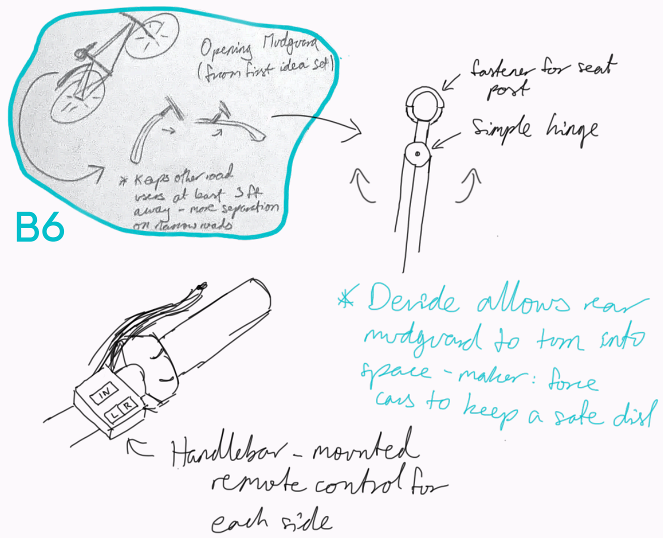
CONCEPT REFINEMENT

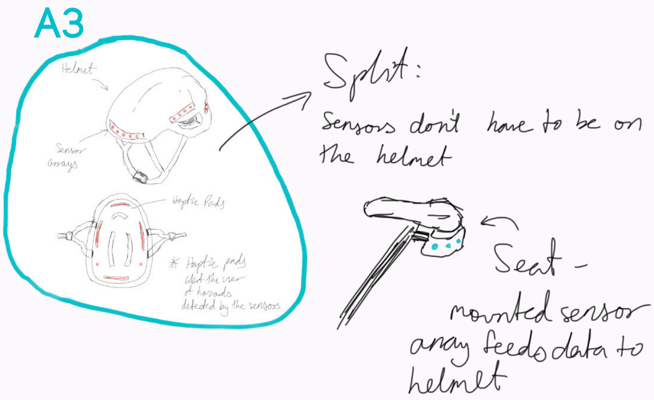
James Howells

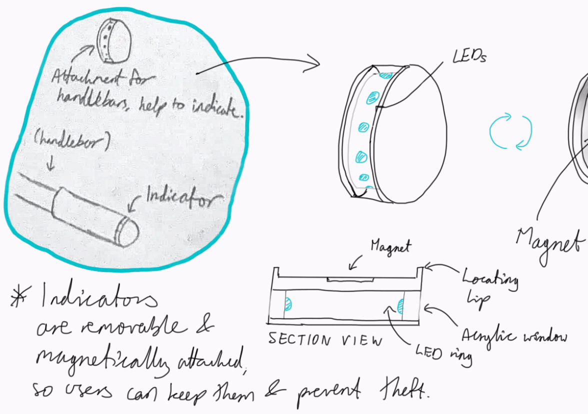
Based on insights, research and user feedback, I've made another iteration of some of the ideas. Original ideas are in bubbles with alterations sketched over them.

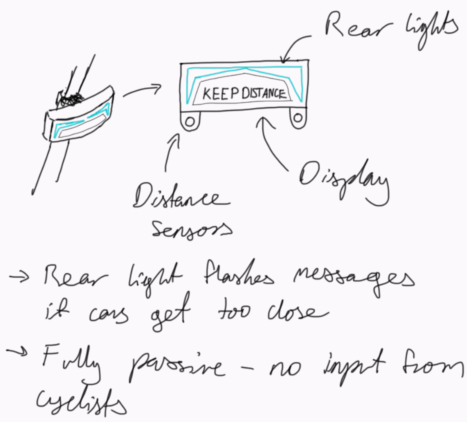












I will now get further feedback from users, and then choose the best of these concepts to develop more fully based on their views and ideas.

CONCEPT SELECTION

James Howells

USER FAVOURITES

AR GLASSES

- Convenient - keeps focus on road
- Might be quite heavy & cumbersome

INDICATORS

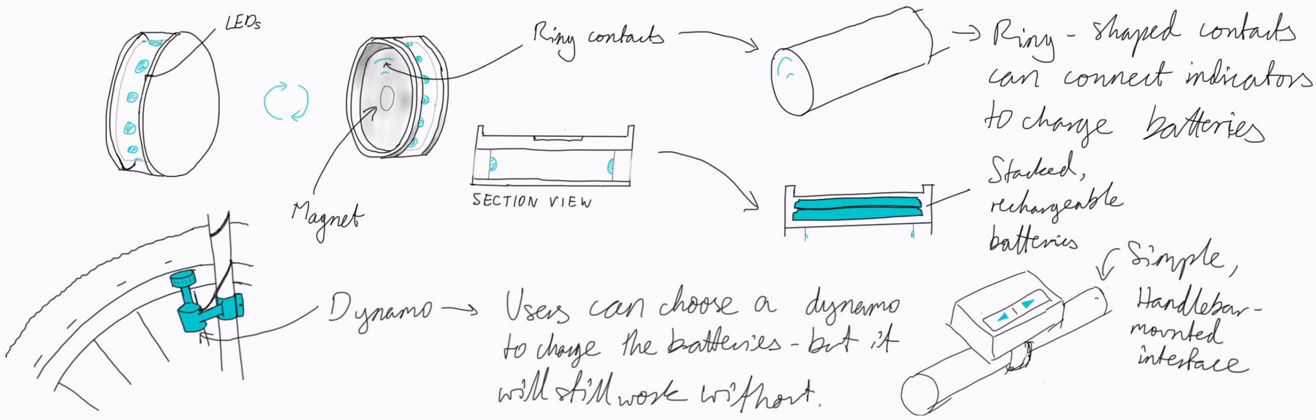
- How would they be actuated?
- How often would they need to be charged?

SMART HELMET

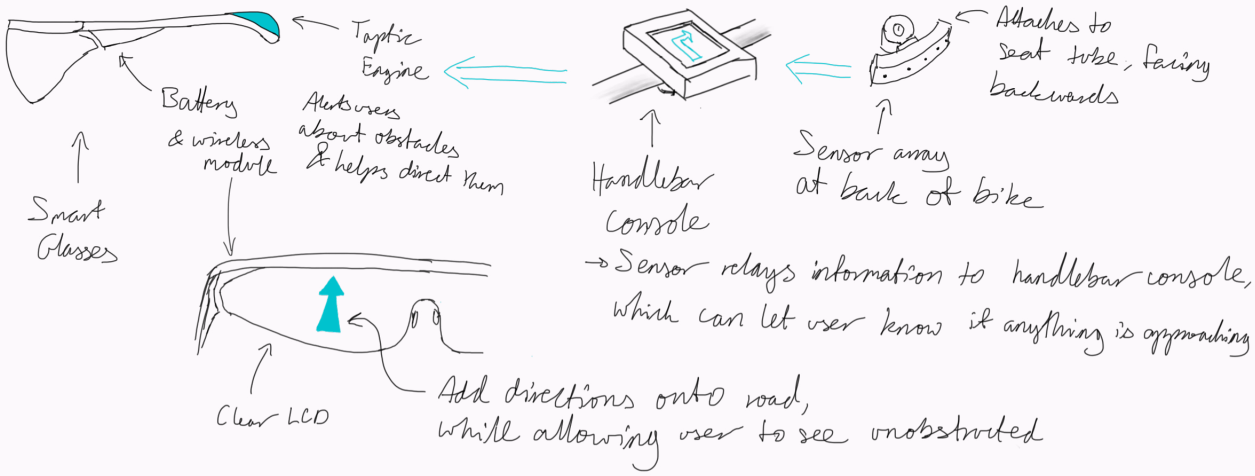
- Could it be used for navigation as well?
- Again, how often would it need charging?

Users selected the above three ideas as their favourites, and gave some comments. I have iterated them further.

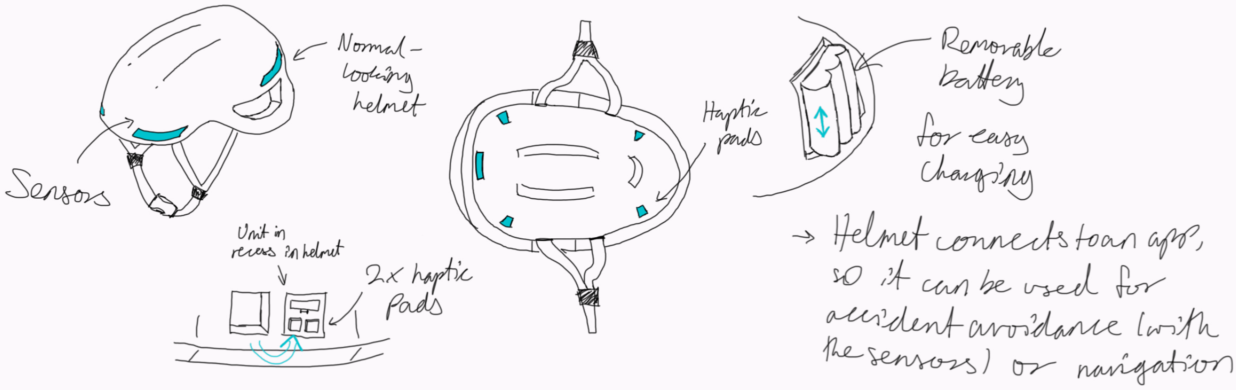
CONCEPT 1



CONCEPT 2



CONCEPT 3



These ideas all seem promising: users would like to see more fully developed and better visualised concepts, so I will create low-fi CAD models of each concept.

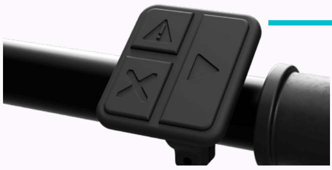
DEVELOPMENT

James
Howells

I started 3D development with very basic CAD models of each of my concepts, which highlighted some problems on each.

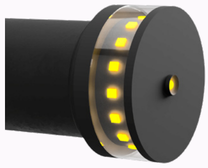
CONCEPT 1

FIRST VERSION



Two consoles would be used instead of the one shown on the sketches: this is easier for users to reach.

At first, I made the console buttons black. They were hard to see.

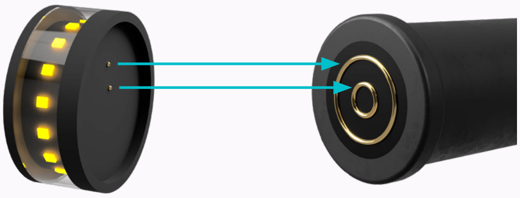


END LIGHT

After feedback, I added an LED to the end of the light for better side visibility.

CONNECTORS

Magnets hold the lights onto the handlebars. Users can add ring contacts for battery charging with a dynamo.



CONCEPT 2

FORMS

Having a CAD model highlights just how bulky these will look. Any future iterations need to prioritise size.

CONSOLE

The handlebar console provides the processing power for the glasses, and can guide the user if the glasses' batteries run out.

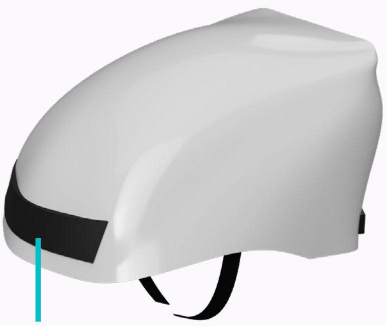
HAPTIC MOTORS

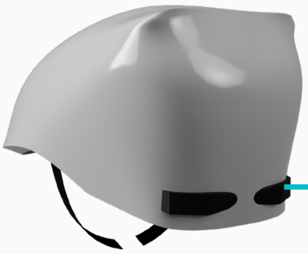
A small haptic engine, to warn of oncoming vehicles, is positioned behind each ear.

CONCEPT 3

BATTERY

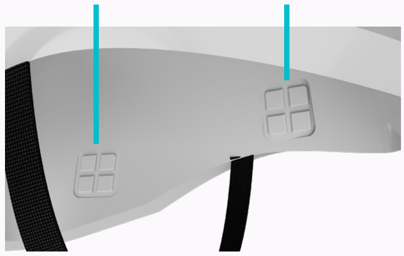
Users found the clunky battery on the previous iteration ugly. The removable battery is now hidden on the inside of the helmet.





HAPTIC MOTORS

This iteration demonstrated a problem: the inside of the helmet is curved, so flat haptic engines will not work. Curved ones would have to be custom-made.



SENSORS

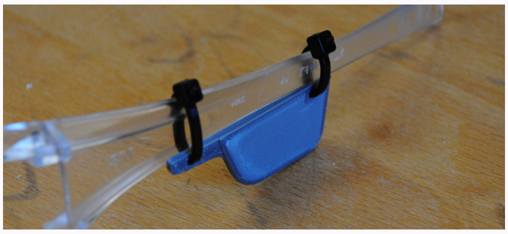
Proximity sensors are hidden behind sleek black panels which give the helmet a distinct look, helping cyclists identify with one another.

Feedback suggested that the helmet is applicable to the smallest range of use cases, as many users simply don't want to wear one. I will merge the other two ideas: the indicators and glasses will use the same handlebar console and be integrated with one another.

PROTOTYPING

James Howells

The shape of the battery casing is important: I am worried it will affect the wearer's peripheral vision. I 3D printed several iterations, which I made so they could be attached to safety goggles using zipties for easy testing.



LARGE

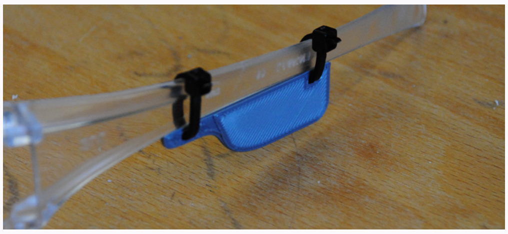
The first size is 50mm long, 20mm high and 2mm thick.

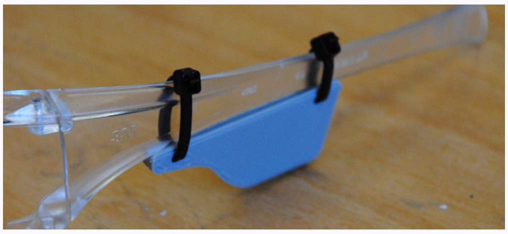
Surprisingly, peripheral vision is completely unaffected, but this iteration did dig into the user's ear.

SMALL

The second one is smaller - it felt too small to be feasible.

The smaller size solved the issue with rubbing on the wearer's ear, but it was too small.





THICKER

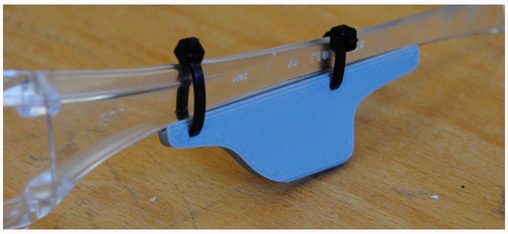
I doubled thickness and added an angle to clear users' ears.

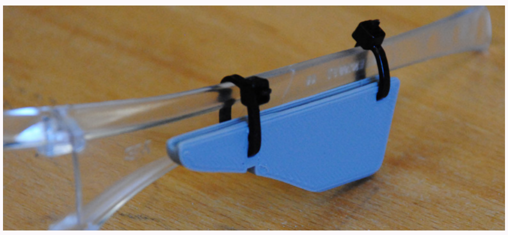
The extra thickness isn't an issue, and the unit now clears users' ears.

EXTENDED

Given the shape of an ear, I tried extending the unit above.

This didn't work. It rested on top of the ear and was quite uncomfortable.





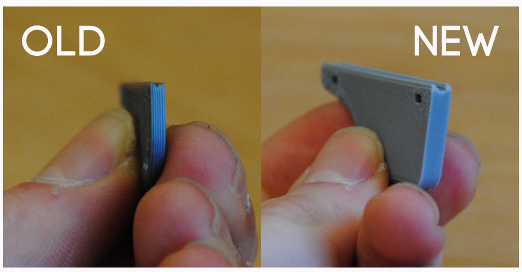
FORWARD

I tried extending the casing forwards to increase volume.

This doesn't interfere with field of view either - the casing could be even bigger if needed.

FINDINGS

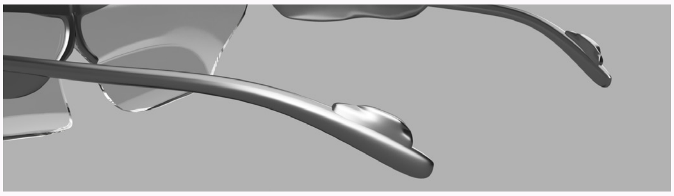
My initial versions were much too small and thin to be feasible (see right). My final prototype was considerably larger, and now has enough internal volume for the components required. Having the casings flat, rather than curved, and with access from one side (see CAD) allows for easier and quicker assembly.



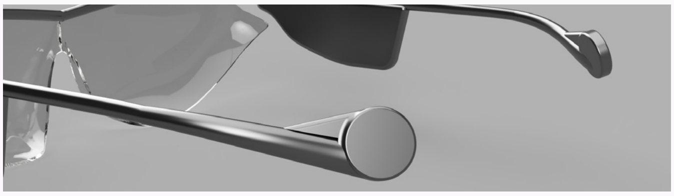
CAD REFINEMENT

James Howells

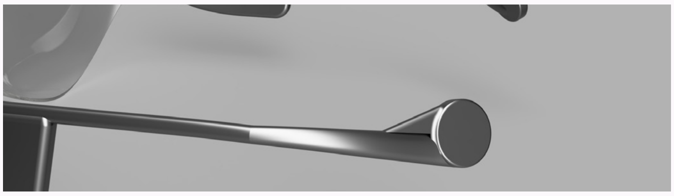
VIBRATION MOTOR



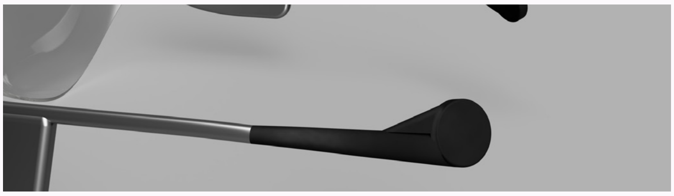
The original motor bump was far too small. I had to enlarge it and make it a more ergonomic shape to fit the motor and keep it in contact with the user's head.



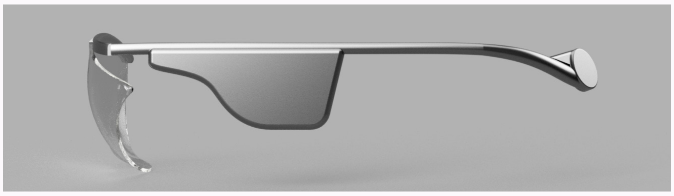
EARPIECE



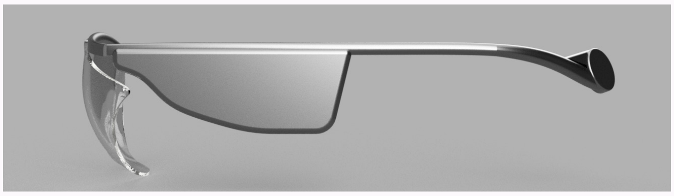
Users pointed out that the motor housing and arm were the same metal as the rest of the unit. I coated them with rubber for added comfort.



RECEIVER & BATTERY CASING



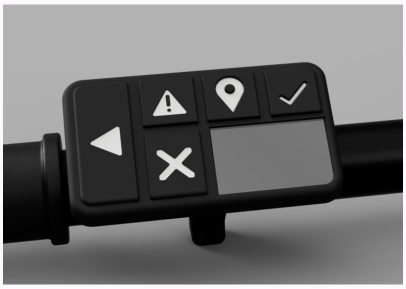
A user pointed out that stretching the console forward (like an extreme version of the 'forward' prototype) would merge it into the back of the eyepiece better.



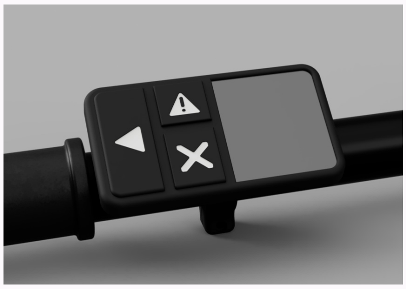
INDICATOR RING CONNECTORS

These brass connector rings used for charging the indicator units were very tall in the first CAD model. I made them smaller, almost flush to the surface, to guarantee the contacts don't slip off.

MINIMAL HANDLEBAR CONSOLE



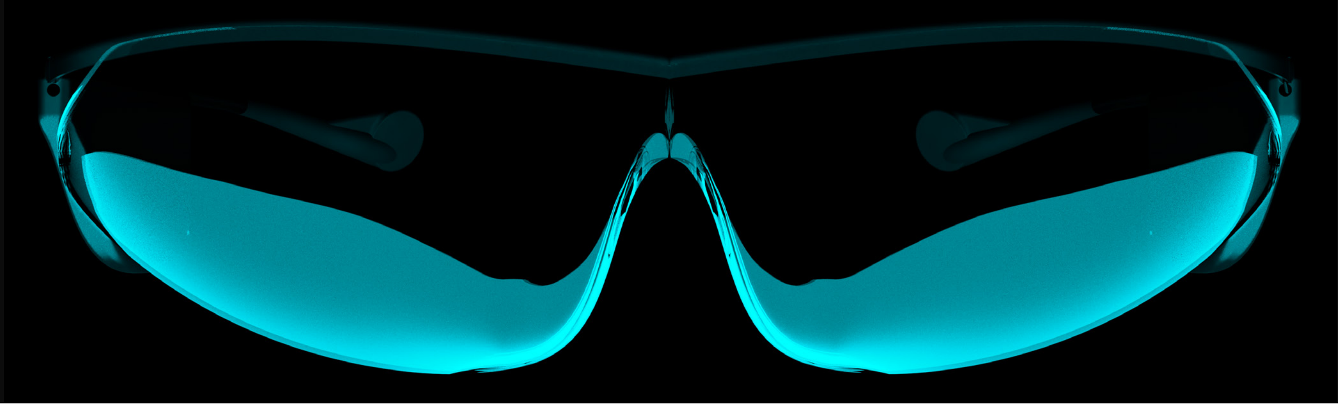
Several users said a phone would be an easier way to set the destination than the handlebar console. Interfacing with a mobile app would allow the console to be much simpler, only needing to **display** navigational information.



I can now turn all of these user-suggested modifications into a final CAD model, and specify internals and components, as well as exactly how they will fit together.

James Howells

FINAL CONCEPT: OCULATE



Arms
(stainless steel)

Vibration Motor Case
(stainless steel,
overmolded
elastomer)

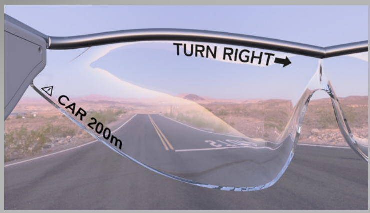
HAPTICS

Haptic feedback alerts users about hazards behind them, such as approaching cars.

Electronics casings
(ABS, injection
molded)

INFORMATION

The eyepieces, made with clear LCD screens (available fairly cheaply - exact shape would have to be custom), show navigation information.

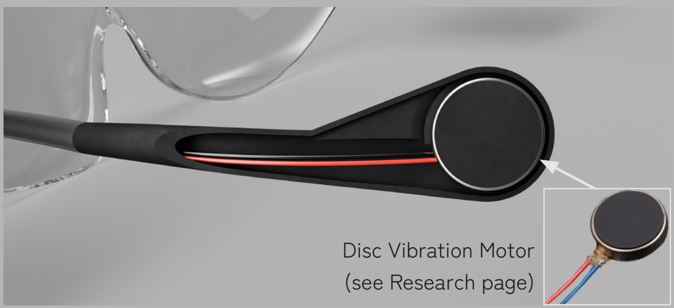


Navigation & hazard
warning on the glasses

VIBRATION MOTORS

Eccentric-mass vibration motors:

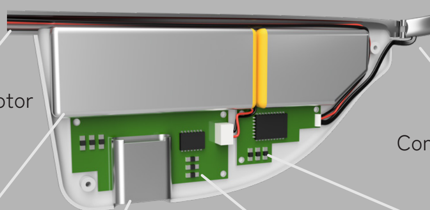
- Embedded in the arms above users' ears
- Alert users about unseen dangers through vibration
- Vibrate their own casings, no extra transmission needed



Casing covers are screwed on for easy servicing of components

ELECTRONICS

Electronics are in the side casings. Three batteries, (capacity around 200 mAh) power the glasses - details below. Bluetooth is used to get data from the handlebar units (overleaf).



LEFT

Vibration Motor
Wires

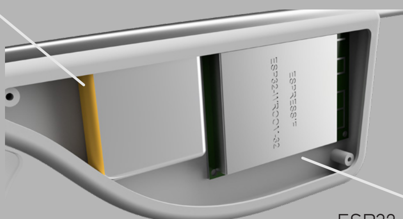
Display
Connector Wire

Display Driver

Batteries

Charging Port
(USB-C)

Charge Controller



RIGHT

ESP32 Microcontroller

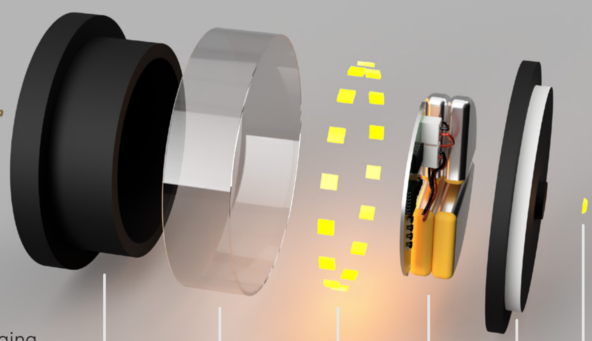
James Howells

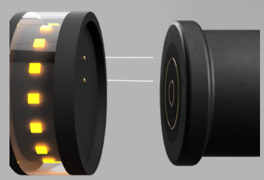
FINAL CONCEPT: OCULATE

INDICATORS

The indicator units:

- Are magnetically attached so can be removed for theft prevention
- Charge themselves from the bike's dynamo (if fitted)
- Detect surrounding hazards with their proximity sensors



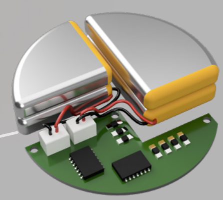


The indicator units charge from the bike's dynamo (if fitted) through these ring-and-dot connectors.

DFA

To ease assembly:

- Indicator unit is all built into its housing from the top, without rotation
- Electronics in glasses are inserted into casings from one side only
- Using a processor with built-in bluetooth capability reduces assembly time.



The electronics contain:

- Batteries
- Battery charge controller
- LED drivers
- IR proximity sensor drivers

in a custom, round circuit.

CONSOLES

There is one console for each indicator:

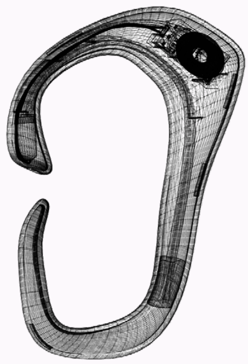
- Right console controls right indicator
- Both consoles can turn indicators off, as well as set 'hazard' warnings, where both indicators flash.

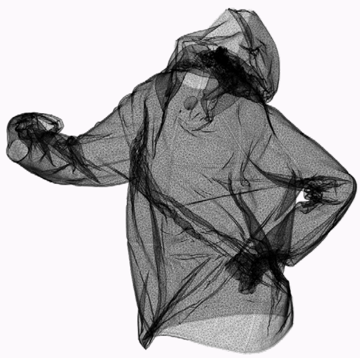
In addition to controlling the left indicator, the left console:

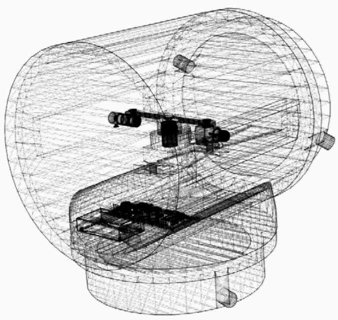
- Has a built-in navigation display
- Connects to users' phones to allow them to set the destination
- Relays navigation and hazard detection information to the glasses

It is controlled by the same type of ESP32 as in the glasses.

Left (main image) and right (inset) consoles are different.
Only the left one needs to communicate with the glasses.





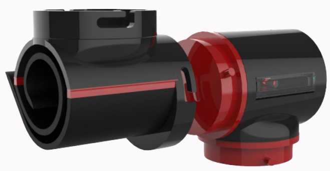


SURVEY

Following our research documentation and concept ideation, we want to hear feedback from you. Please fill out this short survey. Your feedback will be invaluable in helping us select a product to develop further in the next phase of our project.

ROUTEC

EYE-Q



SPACELER

OCULATE

1. Which functions are most important to you? (Tick all that apply)

- [ ] Spatial awareness
- [ ] Navigation/directions
- [ ] Incoming traffic
- [ ] Increase visibility

2. Which ways of communicating information on the road are the most effective? (Tick all that apply)

- [ ] Vibrations
- [ ] Auditory
- [ ] Visual
- [ ] Tactile

3. You would interact with these products in different ways. Which location would you prefer? (Tick one)

- [ ] On the bike
- [ ] On the user
- [ ] On your phone (app)
- [ ] A combination

4. Which product is easiest to put on to install on the bike/put on to wear? (Tick one)

- [ ] Routec
- [ ] Eye-Q
- [ ] Spaceler
- [ ] Oculate

5. Which product would be the most difficult to integrate into your daily routine? (Tick one)

- [ ] Routec
- [ ] Eye-Q
- [ ] Spaceler
- [ ] Oculate

6.Which product seems the most intuitive to use? (Tick one)

- [ ] Routec
- [ ] Eye-Q
- [ ] Spaceler
- [ ] Oculate

7. Which product is the most visually appealing/ cool? (Tick one)

- [ ] Routec
- [ ] Eye-Q
- [ ] Spaceler
- [ ] Oculate

8. Which product would distract other road users the most? (Tick one)

- [ ] Routec
- [ ] Eye-Q
- [ ] Spaceler
- [ ] Oculate

9. Which product do you feel best creates a natural separation between you and other road users? (Tick one)

- [ ] Routec
- [ ] Eye-Q
- [ ] Spaceler
- [ ] Oculate

10. Overall, rank the concepts from 1 (favourite) to 4 (least favourite)

- [ ] Routec
- [ ] Eye-Q
- [ ] Spaceler
- [ ] Oculate

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