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DESIGN DOCUMENT

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DE1226 Collaboration & Professional Associations 01 (IMD)

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PART 1: BRIEFING & INITIAL RESEARCH

THE BRIEF

OBJECTIVE

Using ‘Advanced Textiles’, improve wellbeing or the quality of life.

Provide added value to the wearer of the fabric in the developed design solution.

ADVANCED TEXTILES

What are they?
Why and how are they currently being used?
Who is using them?
What's around the corner?
The technical and emotional/social qualities?

SEAMLESS SOLUTION

One that ensures a useful interaction between physical products and digital worlds, to solve the identified issue.

LIFE CYCLE

Explore the full life-cycle of the materials chosen, including source, manufacturing and end of life scenario.

WEARABLE RESEARCH

MARKET RESEARCH

Great Britain is the largest market in Europe. Health and fitness trackers represent 53% of the market, followed by smartwatches with 32%.

http://www.gfk.com/insights/infographic/tech-trends-2017-wearables/

What makes smart fabrics revolutionary is that they have the ability to do many things that traditional fabrics cannot, including communicate, transform, conduct energy and even grow.

https://www.forbes.com/sites/forbesstylefile/2014/05/07/what-is-the-future-of-fabric-these-smart-textiles-will-blow-your-mind/#64f331f3599b

It's up to us to define how we tap into the many modalities of the body through clothing as the interface to help us navigate the world, communicate, entertain or generally bring us greater understanding of ourselves.

http://www.wired.co.uk/article/smart-fabrics-beat-smart-devices

MARKET RESEARCH

Are we ready to give up cheaper traditional clothes for smart garments?

https://www.wareable.com/smart-clothing/smart-fabrics-labs-designers-startups-9118

Sensor-based smart fabric, could redefine the connected fitness and health industries and beyond.

https://newsroom.cisco.com/feature-content?articleId=1644611

Wearables will become “disappearables” as the devices become the garment itself.

https://www.ypo.org/2017/05/fashion-meets-function-with-smart-fabrics/

The concept of embedding woven sensors has been well and truly taken on board, with companies such as Athos and MyZone producing integrated wearable performance monitors that go way beyond existing HR bands and straps.

http://www.techradar.com/news/wearables/wear-we-re-going-smart-fabric-tech-that-will-change-the-world-1322393

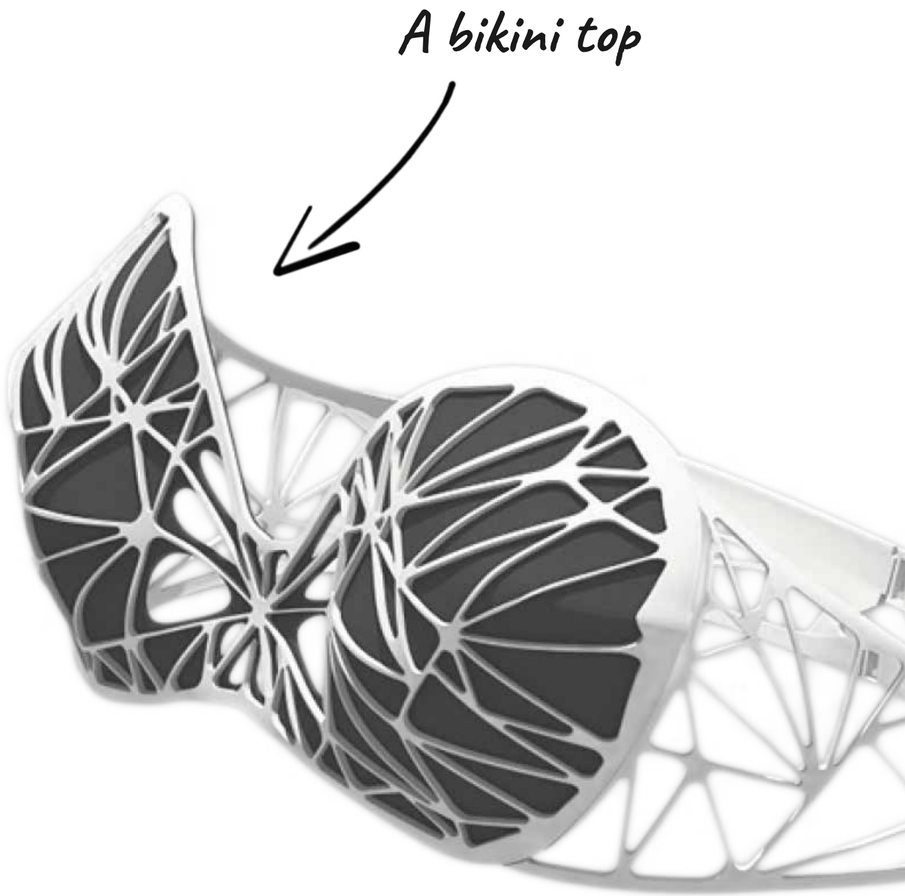
WATER FILTRATION BATHING SUIT

Concept
A bathing suit that cleans surrounding water as you swim around it.

How it works
A reusable material created from sugar has been applied to a bathing suit by engineers in California. It is hydrophobic, meaning it repels water, but absorbs harmful contaminating chemicals.

It then holds the harmful substances until it is heated to a very high temperature. It doesn't transfer any contamination to the wearer, so it is both safe for the environment and potential users.

Things to take away
- Positive impact on environment, with a sustainable life cycle
- Cost effective
- Other possible applications, such as paint for planes and satellites, have been considered
- The interaction is invisible



https://www.wearabletechnologyinsights.com/articles/8594/bathing-suit-cleans-the-water-as-you-swim

TOXIC GAS DETECTING FABRIC

Concept
Fabric that can detect dangerous gases in the surrounding environment.

How it works
Graphene coated fabrics are triggered by the harmful gas nitrogen oxide, and respond by sending electronic signals that then can light up an LED.

The tests were successful and the fabric was sensitive to a very small amount of gas, however it was still over the acceptable U.S. Environment Protection Agency standard.

Things to take away
- Sustainable for mass production.
- The concept of 'smart filters' was introduced but not expanded on.
- A potential solution to a massive worldwide problem, with possible application still to be explored.
- The interaction is invisible

https://www.wearabletechnologyinsights.com/articles/9243/wearable-graphene-coated-fabrics-that-can-detect-dangerous-gases

ELECTRONIC SKIN

Concept
A new type of wearable health monitor, in a patch-like silicone format, able to track heart rate, breathing patterns and muscle movement.

How it works
50 separate components are connected within the coin sized patch, that is easily wearable for any user. It transmits all of the data gathered to a developed smartphone application.

Wireless charging and a complex structure ensure the device is long lasting and sustainable for tracking health and fighting against disease.

Things to take away
- A more flexible, smaller solution to common wristband trackers.
- It's possible to transmit data over to other devices.
- Added flexibility ensures their are more wearable applications.

https://www.wearabletechnologyinsights.com/articles/11575/electronic-skin-takes-wearable-health-monitors-to-the-next-level

BREATHABLE WORKOUT SUIT

Concept
Sports apparel with ventilating flaps that open and close based on the moisture and heat of the body.

How it works
Woven into the material are live microbial cells, that expand when a user becomes warmer, and shrinks when they cool down.

Cleverly, the sensors are the reactors. They is actually no electronics within this particular example of an intelligent fabric.

Things to take away
- The MIT researchers also designed and developed a shoe lining with a similar concept.
- The use of cells are completely safe to touch and consume.
- Natural shape shifters are an alternative to electrical components using classic biology to improve the limited human skin.

On the image, the red spots are where the piece of apparel has identified hot spots and opens its 'ventilation' to cool down

https://www.wearabletechnologyinsights.com/articles/11086/researchers-design-moisture-responsive-workout-suit

CLOTHING FOR ECZEMA

Concept
Clothing that will release treatment for skin conditions.

How it works
Oils and treatments are packing into microscopic pockets, that are programmed to release when the bacteria that causes the skin condition is present.

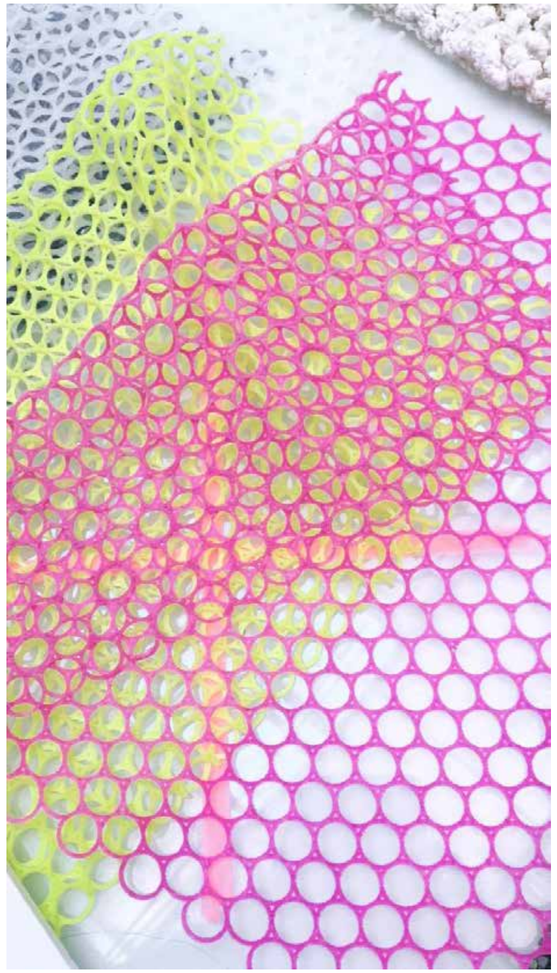
These capsules are attached with covalent bonding, which ensures a standard washing machine cannot break up the capsules.

Things to take away
- An alternative to skin creams and oils that produce a lot of waste.
- The nanotechnology used will last with the garment, with the natural oils having a lifespan dependent on the skin infection.
- The interaction is not obvious or noticeable to the user, yet the result is appreciated massively.

https://www.wearabletechnologyinsights.com/articles/11086/researchers-design-moisture-responsive-workout-suit

NORTHERN DESIGN FESTIVAL RESEARCH

Material Matters was an exhibition featured at the Northern Design Festival. We decided to take this opportunity to gain some expert knowledge and insight into upcoming designs and innovation within the e-fabric and textile world.



SMART FABRICS

RESPONSIVE MATERIALS

Examples

Responsive Polymers,
Environmental Gels,
Chromogenic Inks

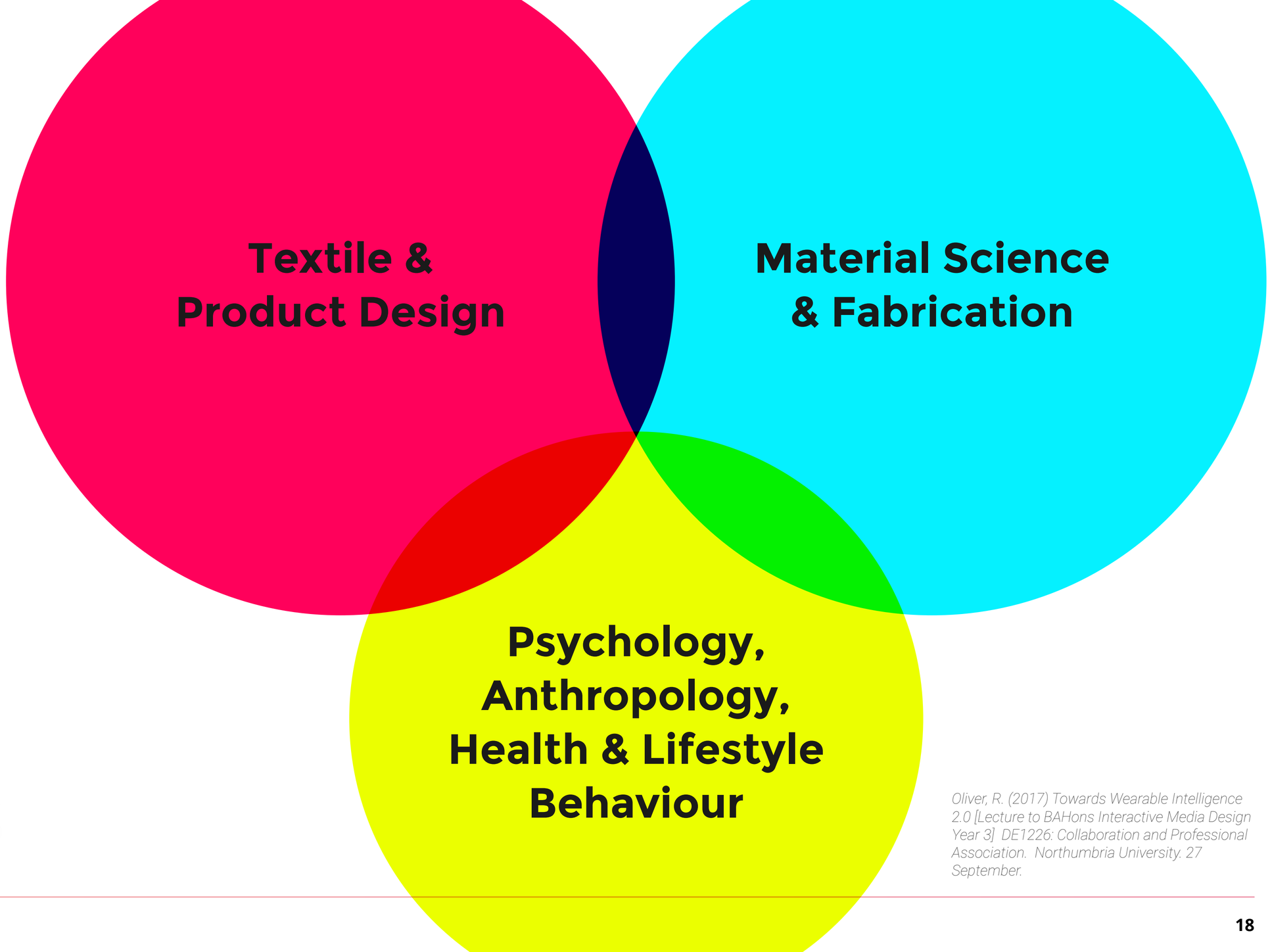
Key Triggers

Temperature, Pressure,
Light, Pathogens,
Sound, Electricity

Key Responses

Colour,
Opacity,
Volume (ERH's)

Oliver, R. (2017) Towards Wearable Intelligence 2.0 [Lecture to BAHons Interactive Media Design Year 3] DE1226: Collaboration and Professional Association. Northumbria University. 27 September.



SMART TEXTILES

Oliver, R. (2017) Towards Wearable Intelligence 2.0 [Lecture to BAHons Interactive Media Design Year 3]. DE1226: Collaboration and Professional Association. Northumbria University. 27 September.

RESPONSIVE POLYMERS, GELS & ELASTOMERIC SHAPE MEMORY POLYMERS

When working with advanced textiles, intertwined with technology, we need to thing about what actions will trigger the technology to take action, the following are the triggers that are most commonly used:

Stimuli/Triggers:

- Temperature
- pH
- Light
- Pressure
- Biomolecule
- Sound
- Electricity
- Stress (stretch)

When looking at creating our product, we need to look at the following questions...

- How best to initiate the effect?
- How intense does the trigger have to be?

Oliver, R. (2017) Towards Wearable Intelligence 2.0 [Lecture to BAHons Interactive Media Design Year 3] DE1226: Collaboration and Professional Association. Northumbria University. 27 September.

ARE MATERIALS SMART?

“All materials are responsive, whether or not they are smart materials is a different question”

Culshaw (1996)

Shape memory polymers	Cotton
Phase changing materials	Wool
Electroactive polymers	Silk
Photoactive polymers	Linen
Carbon nano tubes	Viscose
Photovoltaic fibres	Acetate
Electro luminescent fibres	Nylon
Colour changing materials	Polyurethane

Oliver, R. (2017) Towards Wearable Intelligence 2.0 [Lecture to BAHons Interactive Media Design Year 3] DE1226: Collaboration and Professional Association. Northumbria University. 27 September.

IDEA GENERATION

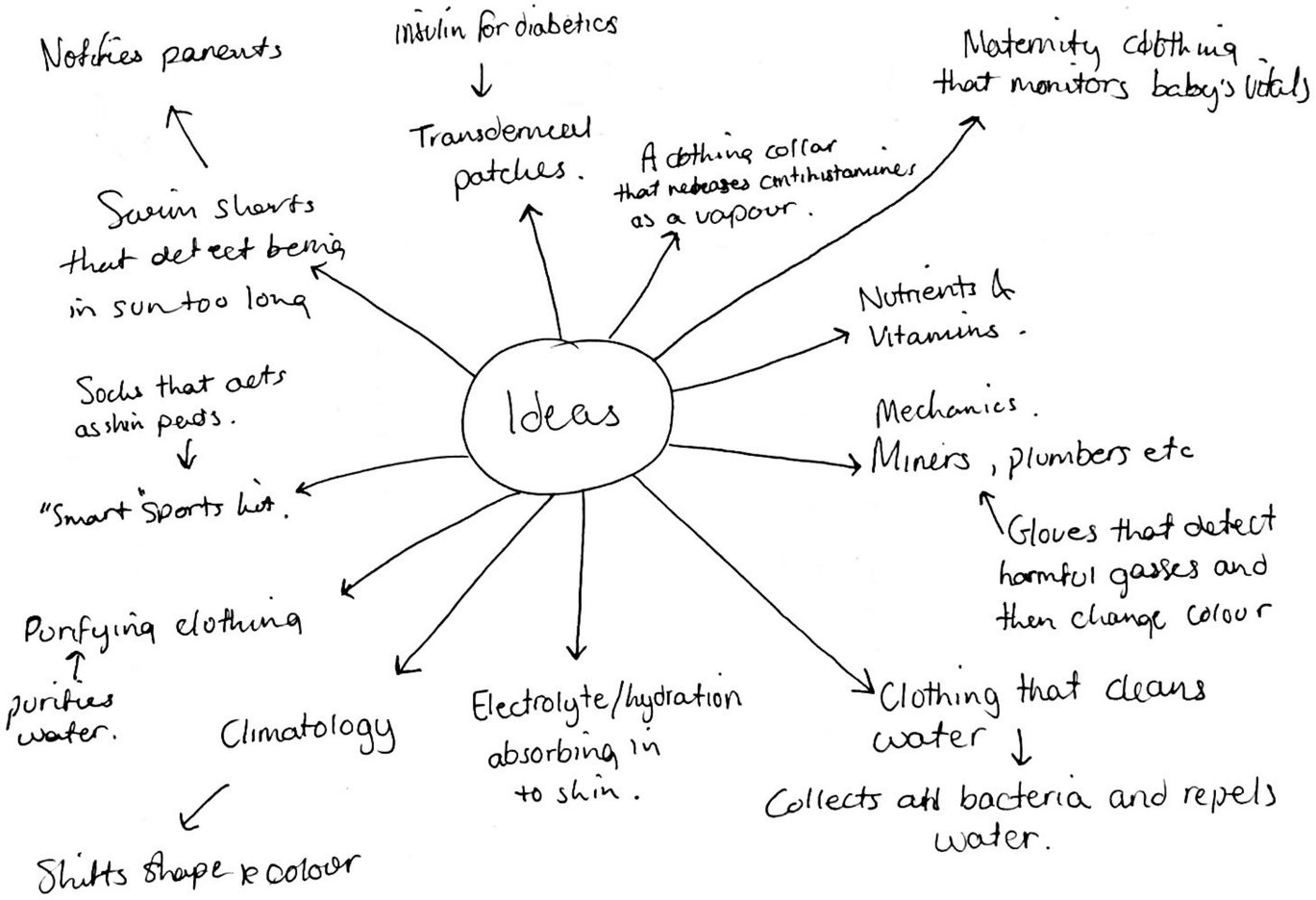
INITIAL PATHWAYS

After breaking down the brief and properly identifying what the objectives and outcomes of the brief were, we could then begin to brainstorm some ideas.

We tried to keep as much broadness to the ideas as we could. This was because we didn't want to start off going down any specific route, helping us keep our options open for further development.

From our mind-mapping exercise, we found a whole range of ideas, but narrowed it down to 3 possible pathways:

- Gas detection gloves
- Filtration clothing for the 3rd world
- An intelligent sports kit



IDEA 1
GAS DETECTION GLOVES

The first idea we considered taking further was a pair of gloves aimed towards the industrial sector such as mechanics or plumbers. The gloves would let the user know that there is harmful gases present in the air, therefore preventing the user breathing in harmful gases.

How would they work?
The gloves would work by featuring a gas-detecting material that would signal to the worker/user that gas is present. For the signal we thought that the gloves could change colour when gas is present, to quickly
notify the user before they inhale anything harmful, therefore looking after the person's health and wellbeing.

IDEA 2
FILTRATION CLOTHING

“More than 840,000 people die each year from water-related disease”[1]. So what can we do about it? We proposed an item of clothing that is a water filter. The clothing would be a reusable t-shirt that a person in a third world country could use to help to at least reduce, or maybe even eradicate, disease in their water. The benefits for this would be an immense increase in a person’s wellbeing as well as their quality of life.

How would it work?
After some research in to similar projects, we found that a lot of similar products embed a reusable material called “Sponge” which is derived from heated sucrose, a form of sugar[2]. The “Sponge” absorbs harmful contaminants from dirty, infected water.

The user would take the garment as a filter, like you would use a coffee or tea filter, which the user would then pass dirty water through, revealing the clean water on the other side.

1. https://www.dosomething.org/us/facts/11-facts-about-water-developing-world 2. https://www.wearabletechnologyinsights.com/articles/8594/bathing-suit-cleans-the-water-as-you-swim

IDEA 3
AN INTELLIGENT SPORT KIT

Being very interested in sport, we both felt like a product aimed towards improving and protecting an athletes wellbeing would be very interesting. The initial ideas we came up with were a pair of under-shorts that could detect lactic acid build up around the quad/hamstring area before the athlete got cramp. Another thought we had was to create a 'kit', mostly aimed towards non-contact sports (football for example), where the kit could detect contact from the other person or opposing team and show on the kit in a different colour, thus notifying the referee to make a decision.

How would it work?
The technology used on the materials would be woven in to the fabrics at a very tiny scale. The materials would use triggers to then perform an action such as a change in colour, or any other action that we seem appropriate and effective.

FINAL DECISION

After speaking with tutors about the 3 ideas, we feel that the sport kit idea has much more longevity in comparison to the other ideas. As a group we are very confident with the idea and feel we can create a solid product

PART 2: RESEARCH & CONCEPT PROPOSAL

SPORT RESEARCH

SPORT STATISTICS

2 million

High school athletes account for an estimated 2 million injuries and 500,000 doctor visits and 30,000 hospitalizations each year.

http://www.stopsportsinjuries.org/STOP/Resources/Statistics/STOP/Resources/Statistics.aspx?hkey=24daffdf-5313-4970-a47d-ed621dfc7b9b

55%

Muscle lesions are the most common category of injuries in athletes and comprise up to 55% of all injuries

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3899907/

nearly half

Overuse injuries are responsible for nearly half of all sports injuries to middle and high school students

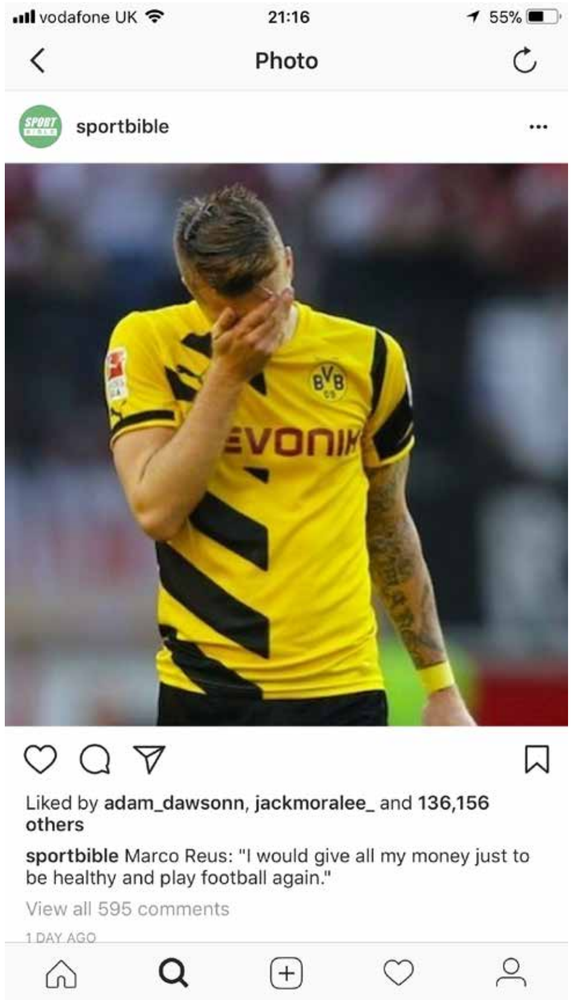
http://www.stopsportsinjuries.org/STOP/Resources/Statistics/STOP/Resources/Statistics.aspx?hkey=24daffdf-5313-4970-a47d-ed621dfc7b9b

5 per game

In total, refs make around five errors per game, meaning they are right 98% of the time.

http://www.skysports.com/football/news/11096/10808860/referee-myth-busting-how-many-decisions-do-officials-get-right

CONTEXTUAL RESEARCH



seb holmes
@sebholmes4
Follow

Pogba injured long term knew we should have signed more needed another cm as back up due to carricks age and needed a lb!!!! Ffs

7:19 am - 29 Sep 2017

1

Michael
@mholdgate1
Follow

Replying to @chriscod1993

Even with video ref you won't always get the same decision on that.. it's down to interpretation. Not as outrageous as people are saying

5:38 am - 9 Sep 2017

1

Eric Goodman
@EricGoodman
Follow

Danny Trevethan was never a dirty player with the #Broncos. But oh my goodness what was he thinking! #Packers #Bears

8:26 pm - 28 Sep 2017

6 Retweets 16 Likes

2 6 16

WelshScouser
@WelshScouser92
Follow

Seriously. What the duck happened to clamping down on shirt pulling? Two blatant pens there! More cowardly refereeing!

9:11 am - 1 Oct 2017

1

Ryan
@ryan3levis
Follow

And Clark's shirt pulling on Lovren is a blatant pen. That, the goal, Gini off the post, this team isn't half unfortunate either.

9:28 am - 1 Oct 2017

1

MATCH OBSERVATIONS

A great form of primary research were real game statistics available from the official Premier League site.

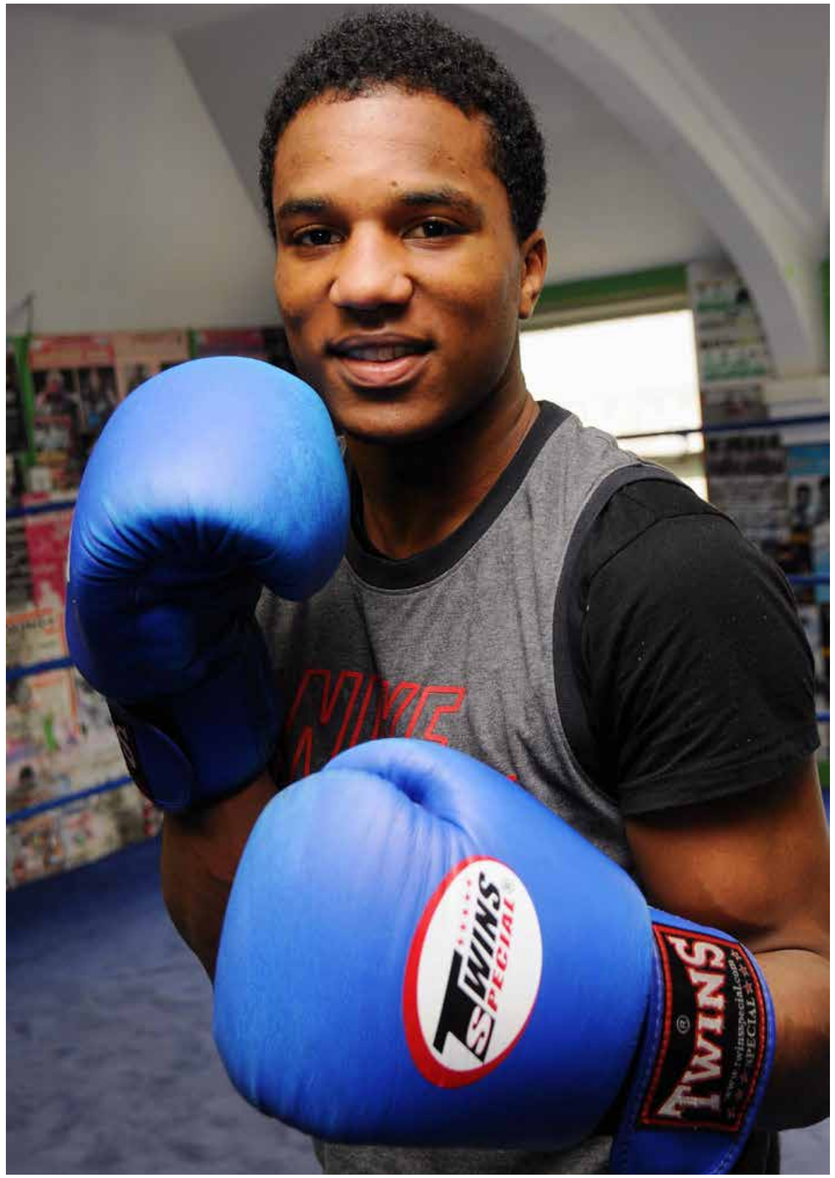
The timeline allows us to revisit the highlights of our favourite games.
We were able to identify patterns for when players were beginning to be substituted, as well as seeing that fouls were much more frequent towards the closing parts of a game.

Head-to-Head | Match Stats

Match Stats

Huddersfield Town		Manchester City
20.5	Possession %	79.5
0	Shots On Target	5
4	Shots	14
357	Touches	914
184	Passes	733
16	Tackles	21
25	Clearances	17
3	Corners	7
3	Offsides	3
2	Yellow Cards	3
1	Red Cards	0
10	Fouls Conceded	10

USER RESEARCH



DAVE
ASPIRING BOXER

Context
Dave is an 18 year old amateur boxer with a dream to turn professional. He trains day in and day out, and a respectful and hard-working sportsman. He plays fairly and expects the same in return. It often gets into his head psychologically when an opponent hits him below the belt, and the referee and judges don't acknowledge this.

Scenario
Dave is just a few wins away from turning professional. He comes up against quite a dirty opponent, who decides to punch him way below the belt as they are clinching towards the end of a round. Dave drops to the floor, struggling to regain his energy and goes on to lose the fight to a very close judges decision. His dream is shattered, all because of a dirty blow, and he couldn't be more angry and upset.

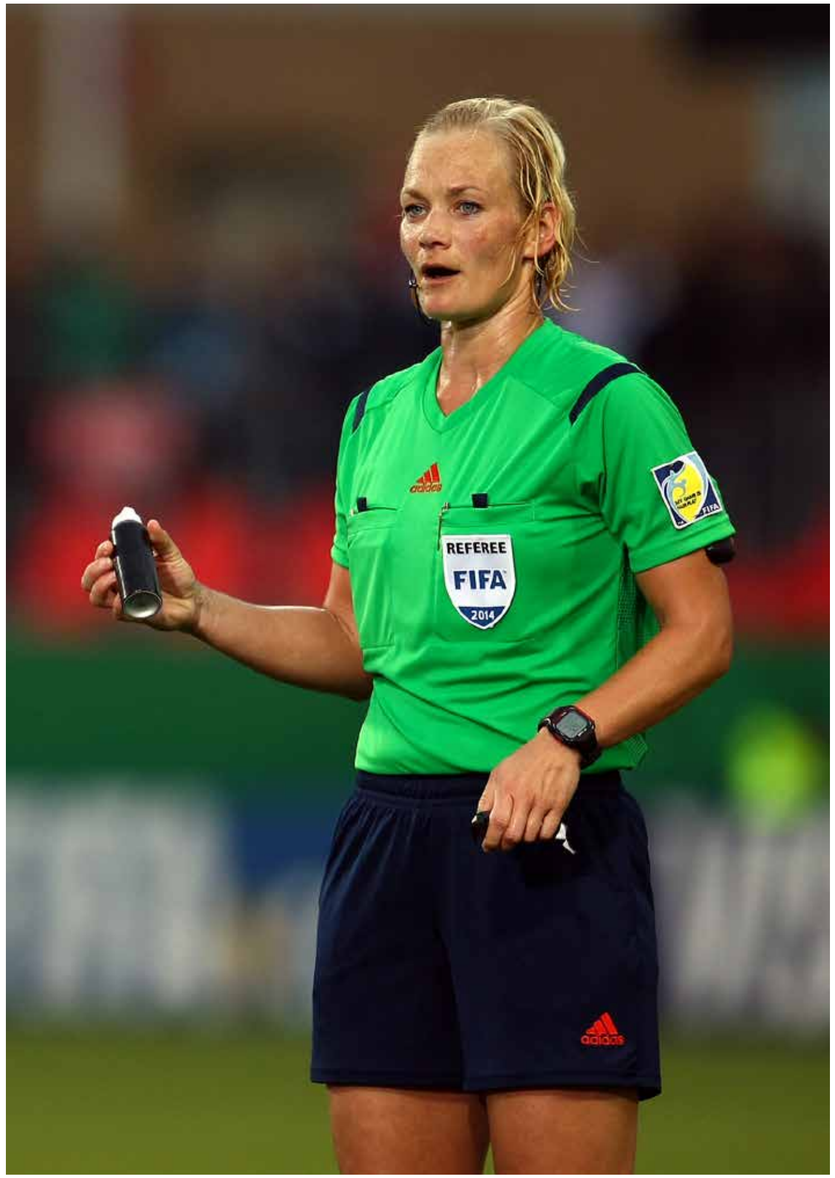
Dave could benefit from some monitory sensor based apparel which could signal a blow to his shorts instead of his upper body, whether this is the changing of colour or a visual alert.

PAUL
PROFESSIONAL FOOTBALLER

About Paul
Paul is a professional footballer for Sheffield United and has been a professional for around 8 years. He has found over the years that a lot of his injuries occur from small set backs such as pulls and strains in his legs. The main culprit is cramp, specifically in his quads. He suffers with cramp in around 35% of games and 25% of training sessions. Paul wants to find a way to spot his cramp early before it takes full effect, enabling him to take himself of the pitch and rest appropriately.

Scenario
Paul is playing a match against Bradford City, he's been on since the start and it is the 78th minute. The score is 1-1 but Sheffield are on the attack and on the verge of a goal. Paul sprints for the ball on the edge of the box but pulls up with serious cramp and drops to the floor. His team lose the ball and concede a goal on the counter attack. Paul feels like he has let his team down and loses some self confidence on the pitch.

This scenario outlines potential for cramp detection on some form of undergarment on the player to prevent the injury.



SAMANTHA
NO NONSENSE REFEREE

Context
Samantha is a qualified referee and loves to follow football. Her love for the game drives her career, and she wants to progress the sport in only the best of ways. She's a very analytical and conscious referee, who gives an unbiased opinion every single time she is called upon. However, 3 or 4 times a game she doesn't always get a clear view of play, resulting in an embarrassing and shameful guess.

Scenario
Samantha is officiating the Women's FA Cup Final and a team's forward falls down inside the penalty area, appealing for a penalty decision. Both teams surround Samantha, arguing whether she dived or whether the defender pulled her shirt and dragged her down. Samantha isn't 100% certain, but goes with her gut and gives a penalty, having no choice but to send the defender off. The team score, and go on to thrash their opponents. Samantha shamefully feels partially to blame for such a score bracket, and worries as to whether she made an incorrect decision.

The benefits of a smart, or intelligent fabric in this situation would be to ensure that Samantha has complete peace of mind when giving her decision. If she has clear evidence of foul play, shirt pulling or a harsh tackle, then she doesn't need to make a decision, but simply enforce the rules of the game instead.

RESEARCH SUMMARY

INSIGHTS

1. The wearable technology market is dominated by smart watches and wrist health trackers, yet the potential and excitement around **embedded smart fabrics** and clothing is huge.

2. There is a huge amount of variety and approaches to smart fabrics and e-textiles, with tests proving **sustainability** as well as **working products**.

3. The most impressive projects are **hardly noticeable**, and go beyond attached electronics.

4. The two main issues that disrupt and affect the outcome of competitive sports are **foul play** and **injury**.

ISSUE

"Muscle lesions are the most common category of injuries in athletes and comprise up to 55% of all injuries" [1]. This single quote summarises our findings; injury is a huge problem in **both professional and amateur** sport competition. Even at a higher standard, muscles continue to be tough to track and monitor in game. Often this results in **cramp, a disruption of play** and the potential to **change momentum** or final result.

Physical injury has emotional affects for all athletes, not to mention drastic financial loss if the athlete is a superstar. In certain tense situations, injury can be used as a **tactical tool to waste time**.

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3899907/

RESEARCH SUMMARY

Wearables are starting to improve the human body's ability to express its condition. Wearables represent the **somaesthetic theory**, by improving the quality of our bodily perception, performance, and presentation [1].

Common perceptions of cramp involving **lactic acid are actually incorrect**. Through research, we have found that the **actual cause of cramp** is a matter is circumstance, relating to the specific individual, environment and activity.

Even though injury is obviously physical, the fear of such a thing can often have **psychological affects** on the player's mentality.

Injury affects many parties in many different sports. There is a space to **involve players, team staff and officials.**

1. *https://www.interaction-design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed/somaesthetics*

REFINING OUR CONCEPTS

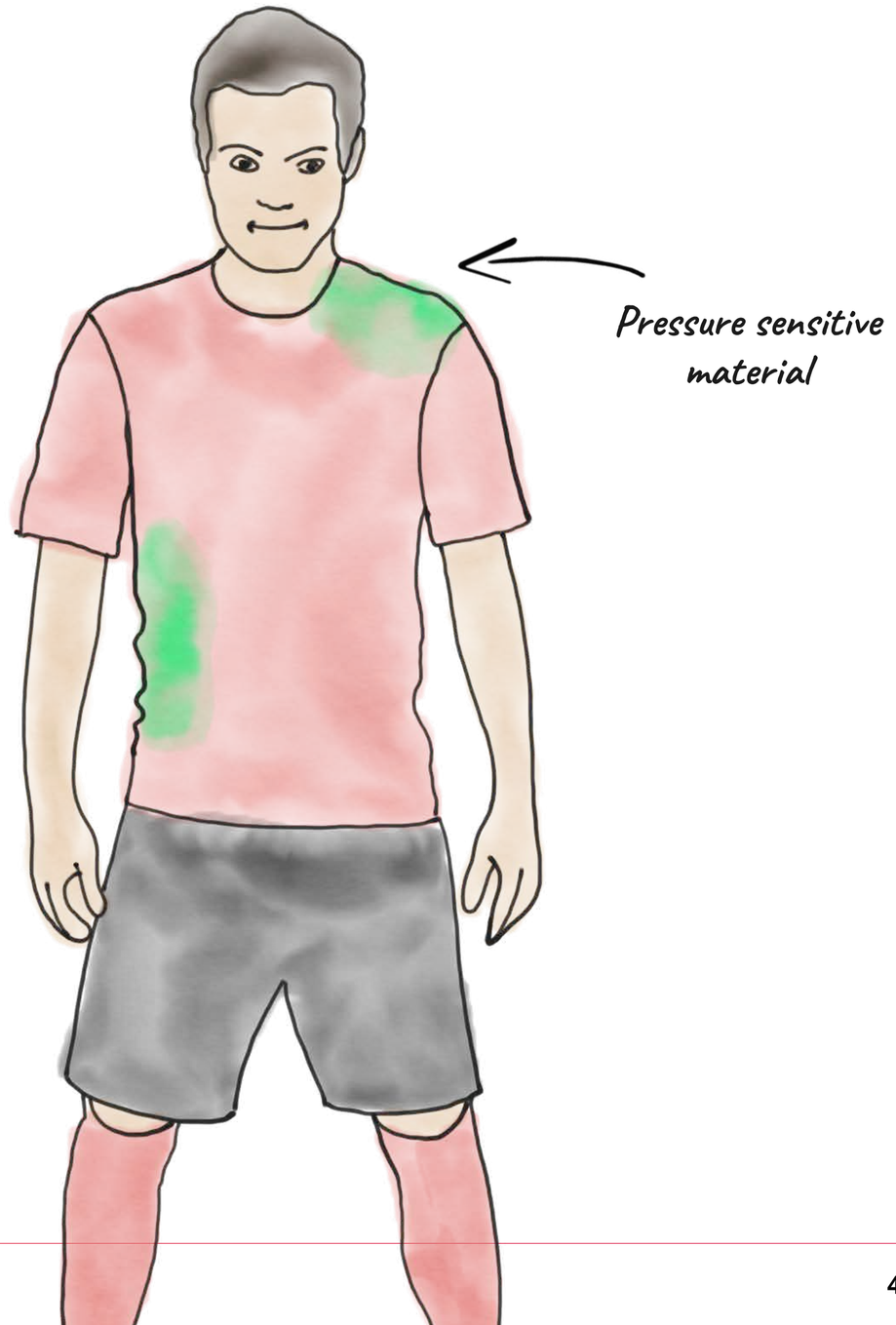
CONCEPT 1
A FAIR PLAY SOLUTION

This concept was initially aimed towards the fair play issue we discover in our sports research.

In efforts to highlight foul play to an official, we conceptualised a sports jersey that would change colour and alert the referee when it was pulled and/or forcefully contacted with. Therefore, this would be aimed towards non-contact sport.

This concept was also considered for boxing shorts, identifying when a fighter has been hit 'below the belt'.

The reason for changing the scope on our project was due to the frequency of foul play in team games such as football or basketball where it would be too difficult to differ.

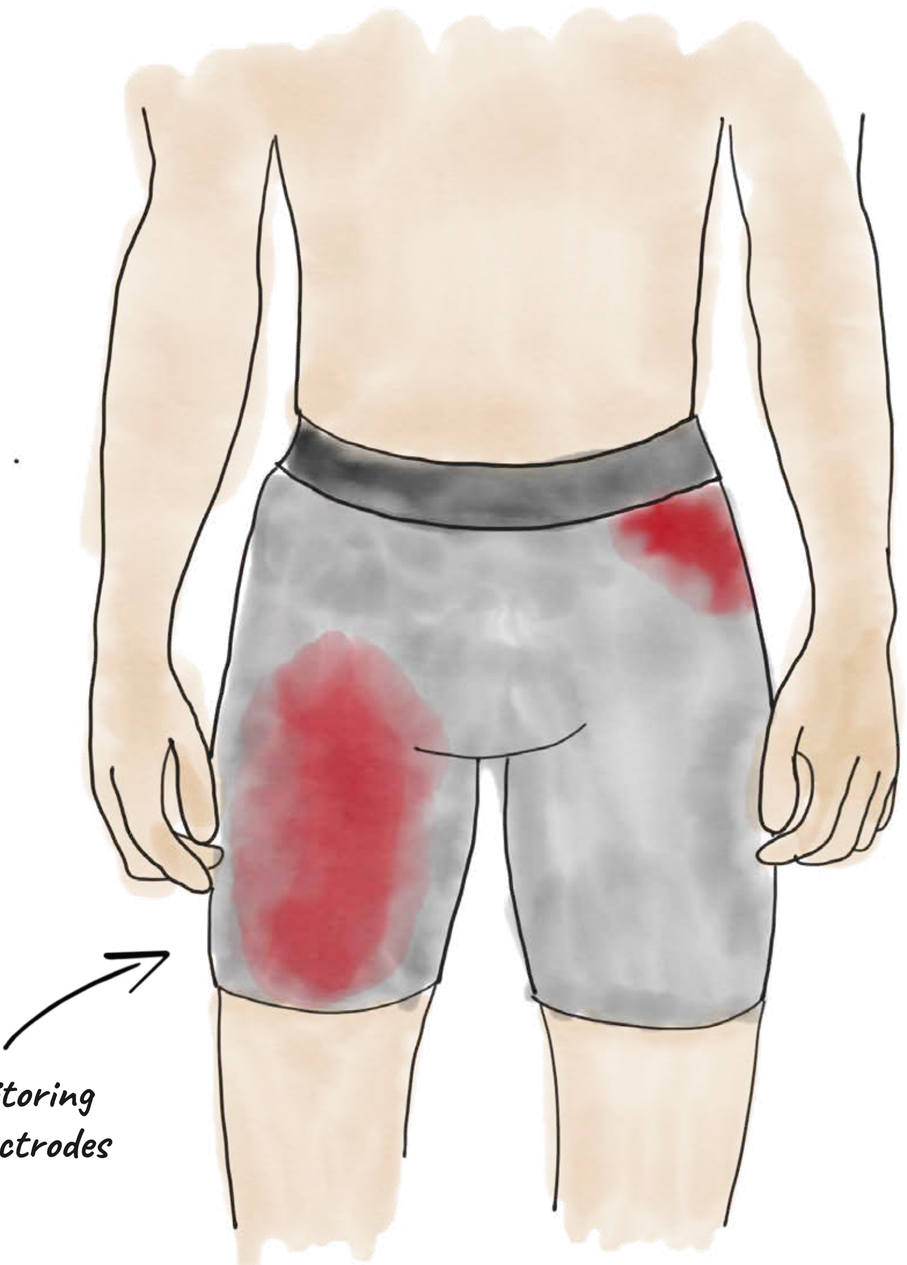


CONCEPT 2
INJURY PREVENTION

This concept is a pair of under shorts that will notify the user of any signs of muscular cramp. It will firstly notify the user by a change of colour in the smart fabric.

Potentially treatment options were to apply heat and apply pressure to the shorts. But due to the versatility of cramp,
we have left the treatment aspect to the user.

This concept is more of an advising tool to act upon by the athlete or concerned party.



USER FOCUS GROUPS

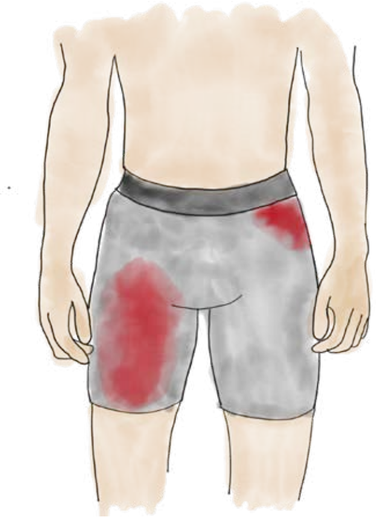
Research Aims
By holding a small, informal discussion amongst 3 sports students, we want to create a casual and interesting debate on our considered concepts. This will hopefully provide us with some insight into potential opinions regarding our niche ideas. Any opinion is valid and useful in this process.

FOCUS GROUP
KEY INSIGHTS

"Specific sports are useful. Rugby, football, basketball & boxing. Not really for the full sport industry though."

"How would it work with teams? As in too much going on. Cost a lot if teams had different coloured kits, hard for referees to track, but I guess you could send something to the third officials."

"What about tracking positions and other data. Can you fit position trackers for offside or out of bounds? Is it useful sending foul notifications instantly to the ref's watch?"



"Is that blood?!? I think the design needs to change, it looks a bit dodgy."

"More marketable. It's more generic in the sport industry. Larger market with potentially more interest in improvement and tracking progress."

"Love something like this. Fitbits and watches are dead annoying. Like way too much effort and money. I wouldn't even realise I had these on, I literally always wear them."

"How would it work? Sounds hard to make. Can it be different colours for different statistics? Or is there another way of displaying things?"

OUR CONCEPT

A seamless monitoring wearable system to identify, intercept and advise on muscular cramp in athletes, using micro sensors and real time data.

MUSCLE MONITORING SYSTEM

Surface electromyography (sEMG) measures muscle fatigue wirelessly.

Sensors woven within the fabric will simultaneously monitor skin temperature and sweat pH levels.

A graphene-oxide printed supercapacitor will be embedded in the short's waistband to subtly power the wearable's notification system.

NON INTRUSIVE SYSTEM

Unlike standard performance monitors, we intend to offer a seamless product that not only acts as an insulating pair of compression shorts, but projects internal activity, externally. Thanks to the sensors used, there is no intrusion to the body; no blood tests, probes or bulky technology is needed.

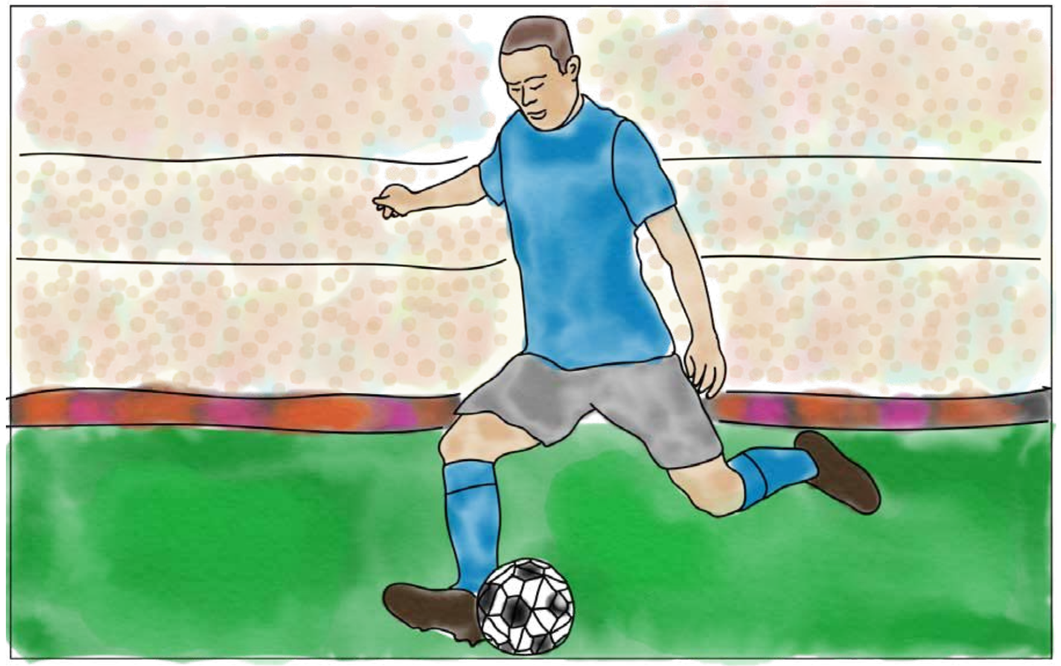
DIVERSE REACTIONS

The muscle and skin data is processed onboard the shorts, triggering a colour change to the electronic fabric.

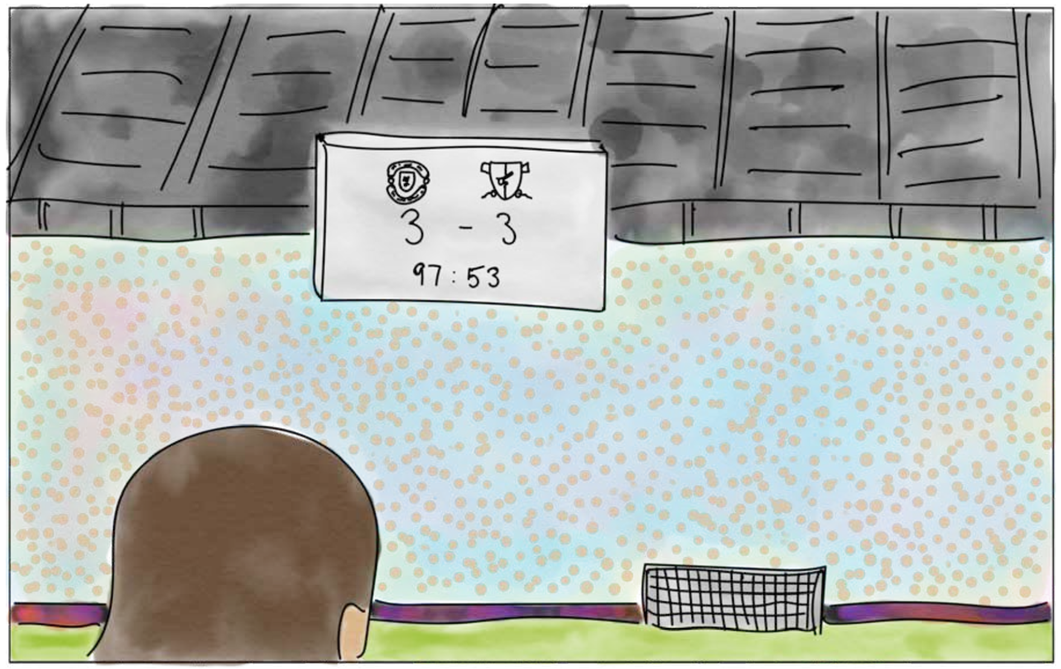
Data is also gathered in a useful mobile application. Amateur individuals can monitor their own bodies, whereas medical staff and data analysts can monitor professional athlete's bodies.

STORYBOARD 1

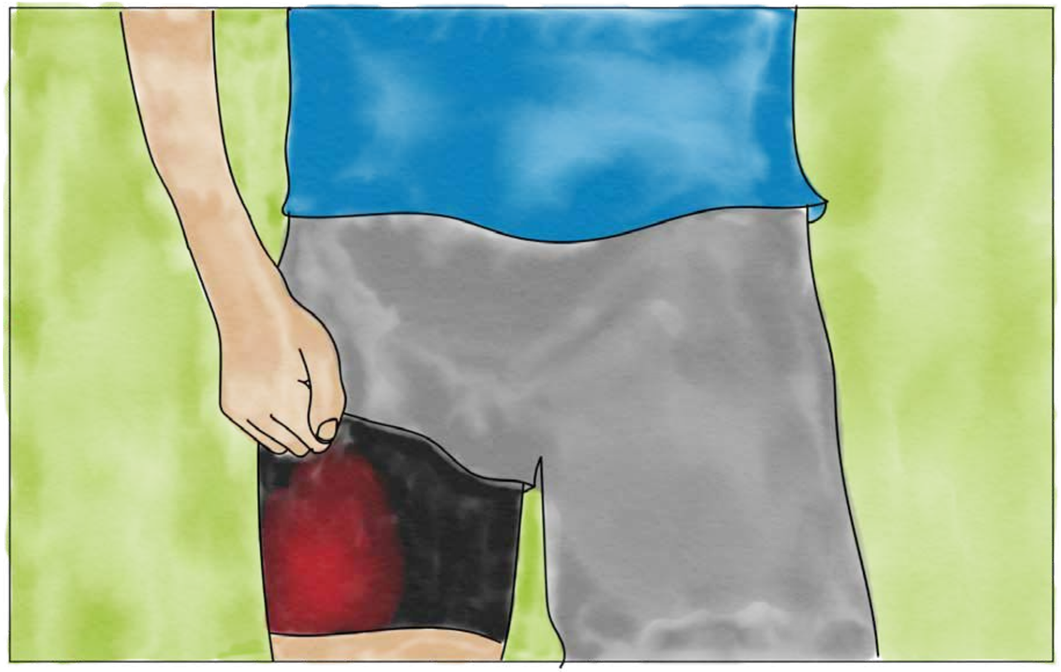
Application for professional athletes



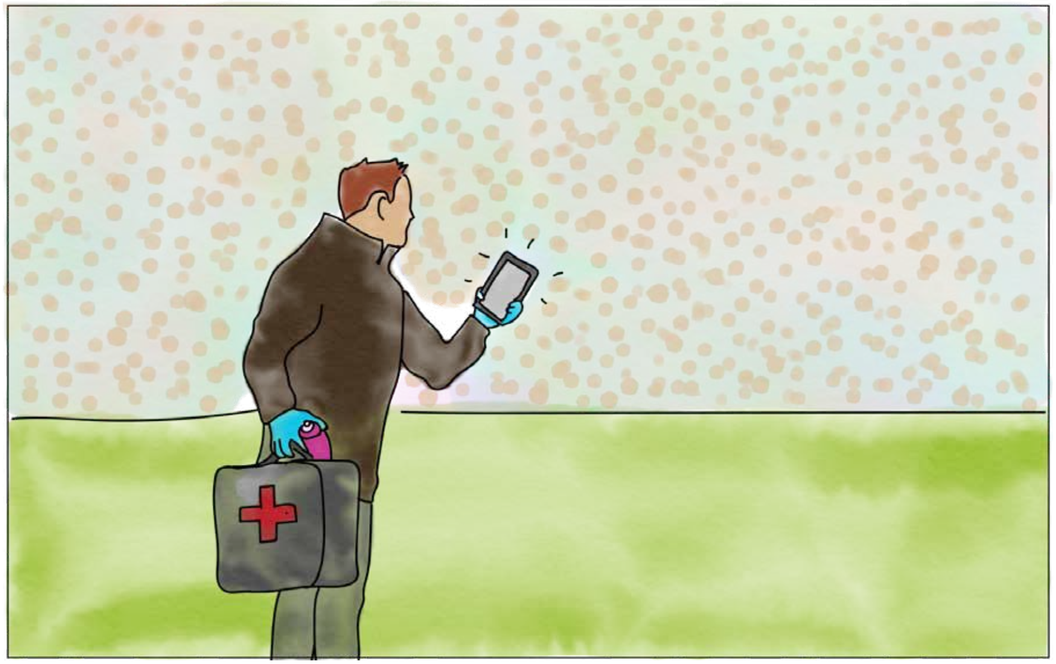
Kyle is an up and coming footballer trying to break in to the Premier League. He puts maximum effort in to his performance, and sometimes forgets about the strain he puts on his body. Possible injury causes him concern in games psychologically as he wants to keep progressing.



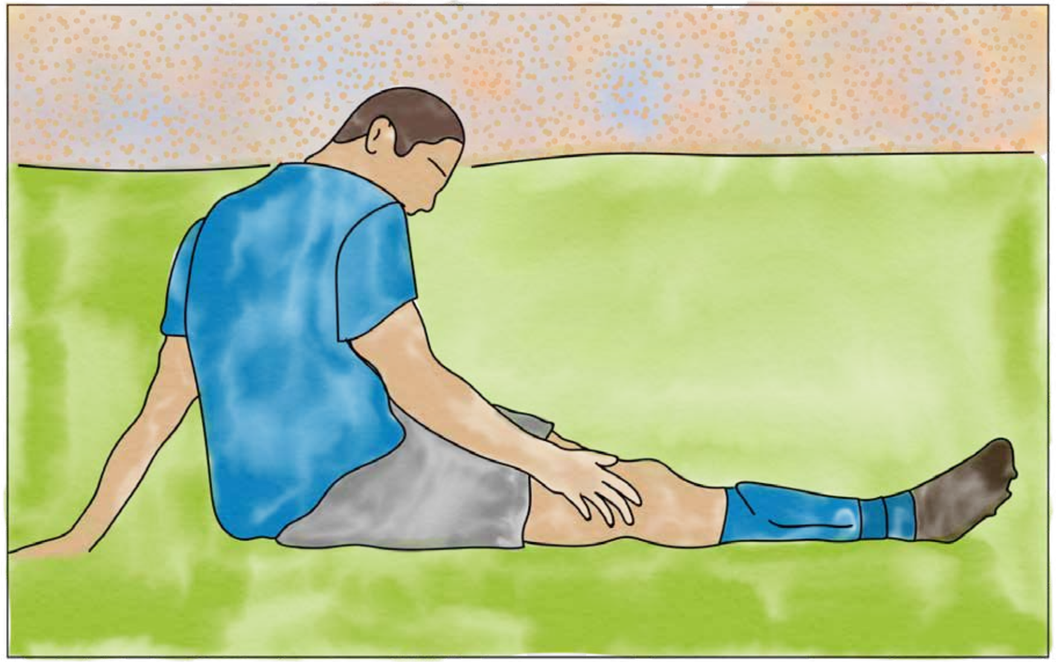
This is an important cup match outlasting the usual 90 minutes. Alex's body isn't conditioned to this intense performance. As his team are drawing the game, he knows he has to increase his work rate even more.



As his nerves are running high and adrenaline takes affect, he wouldn't take any notice of the current state of the fatigue on his leg muscles.
Still worried, he checks his undershorts where he can see any possible risk to his muscles. This helps him make decisions on his gameplay intensity.



As well as Alex's peace of mind, the medical team on the sideline can observe his and fellow teammate's leg states. Any spikes in data or possible concern are sent from the player's shorts straight to the medic's device. This means the medic is well prepared in case he is required.



As predicted from the shorts, Alex has pulled up with cramp. Unfortunately this is part of the game but he was well aware and...

...so was the medic. The time taken to acknowledge the problem was much less than without the seamless wearable. The issue was stretched off and dealt with as quickly as possible, allowing Alex to resume and the game to flow much easier.

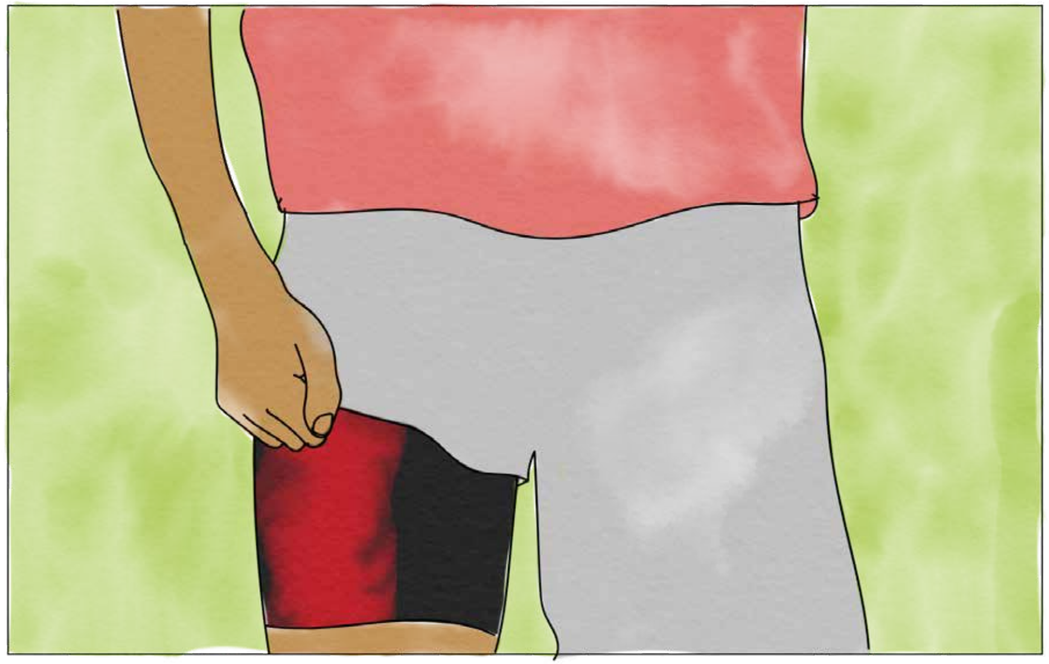
The referee was also kept in the loop. He can clearly see the issue and the accurate data proves that the injury wasn't a tactical time waste. He knows the details and exactly how much injury time to award.

STORYBOARD 2

Application for the average Joe

Steve is a Sunday league footballer who doesn't take the game to seriously. However, what he does take seriously is his physical condition (although he does enjoy a pint every now and then).

Although he is aging and isn't in his peak fitness, he is still as competitive as ever and pushes himself to his limits every Sunday.



The game is coming up to the 60th minute mark and Steve clearly doesn't have 90 minutes in him, judging by the indication from the shorts. Because of this, he signals to be subbed. This way, he can continue to enjoy his beloved game every weekend without injury.

The short's data is compiled in to a handy tool for Steve to reflect on after the match. He can see any frequent problems along with average muscle endurance and how he can manage and improve this.

PART 3: SPECIALIST RESEARCH & CONCEPT DEVELOPMENT

A TRICKY CONCEPT ISSUE!

After some research, we actually discovered we fell victim to a common misconception about muscular cramp.

We initially thought cramp was caused, or at least measured by lactic acid. Infact, there is no scientific research to prove this theory to be correct.

This discovery meant we had to dive straight into the scientific research to discover a new way to monitor muscle condition, and refine our initial idea.

When looking further in to the causes of cramp, we found that no person could really give a definitive answer for why people get cramp. As there are many different ways to get cramp, the triggers would have to be something that remains as a constant throughout the different causes.

As a result of this research, we would need to look more specifically at muscular anatomy as well as each individual factor and decide how we wanted to measure them.

SPECIALIST RESEARCH

MUSCLE CRAMP

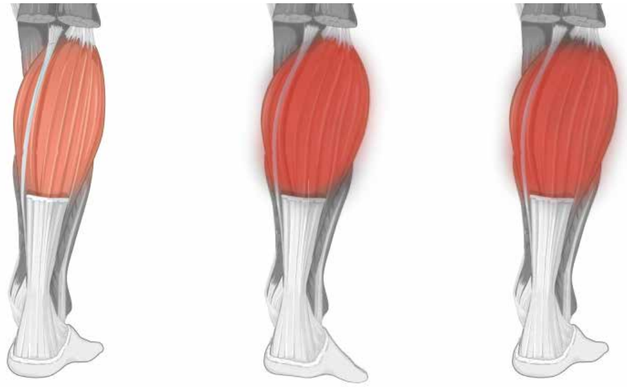
Muscle cramps are very common amongst both amateur and professional athletes. It's described as a 'sudden and involuntary contraction of one or more of your muscles'.

Cramp can often delay sport events, break the flow and momentum of a game, and injure athletes. The most common place to experience cramp is in the legs. It can mostly be the calf or hamstring amongst athletes.

Causes of muscle cramp
There is no one single cause of cramp towards an individual. It can be a factor of things that affect cramp. For example:

- Muscle fatigue
- Dehydration
- Conditioning
- Lack of vitamins and minerals
- Salty perspiration

The Science behind Cramping
A cramp is essentially the muscle continuing to strain even when a person has 'relaxed'.



There are a number of theories as to why this happens. Some believe it is due to the loss of sodium in the sweat of an athlete. Others say dehydration or muscle fatigue, or a loss of electrolytes.

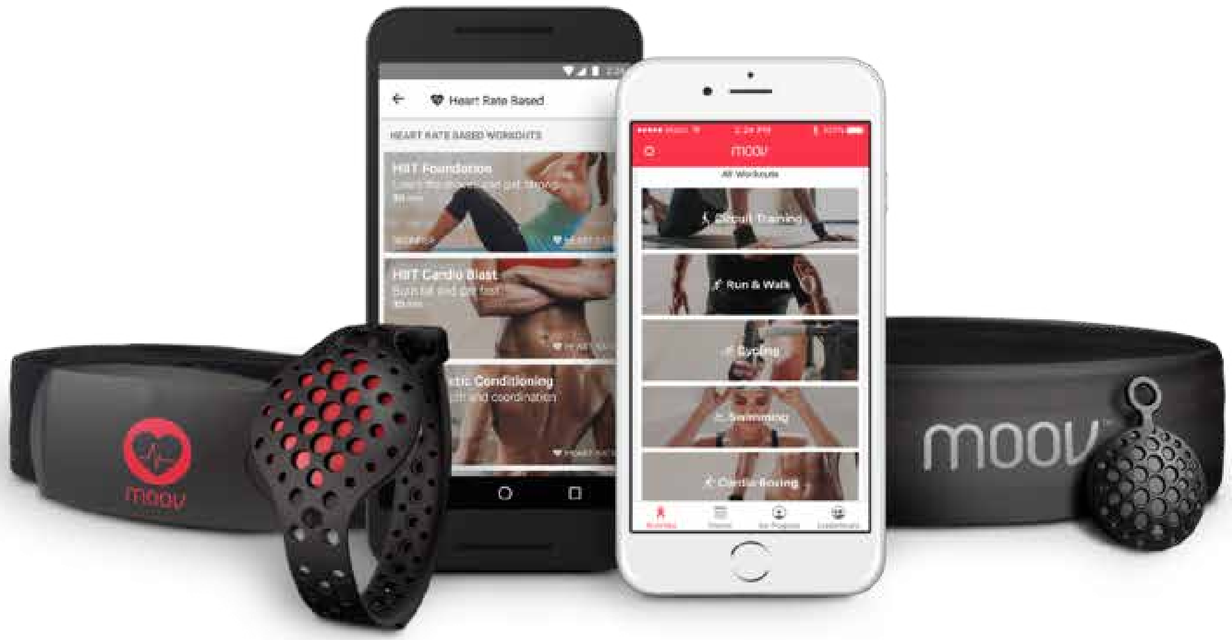
This makes cramp difficult to monitor. The key is to monitor **sweat, skin temperature** and **muscle fatigue**.

EXISTING MONITORING SYSTEM
MOOV

What is it?
A general fitness tracker that comes in the form of a wearable watch or sweat band. Aiming to record physical activity and provide motivation based on the data.

How it works
The product utilizes a range of different sensors and wearables to collect data. It processes data such as heart rate, calories burnt and distance covered through an app, which then gives the user tips of how to improve their workouts.

Point of interest
- Very general towards fitness
- Doesn't address specific sports and their need.
- Noticeable technology (headband etc) - saturated market
- App interface is clear and usable



https://welcome.moov.cc/

EXISTING MONITORING SYSTEM
KENZEN

What is it?
A smart patch called ECHO with real-time sweat analysis that continuously measures hydration, vital signs and a set of key biometrics.

How it works
Combining various sensor technologies and algorithms, ECHO provides real time feedback on performance, motion and vitals. The patch's sensors analyse critical biomarkers, like sodium and potassium, all from a single bead of sweat.

Point of interest
- Connotations of medical examinations through application of the device, leaving the user uncomfortable
- The technology in the device is solid
- Application delivers data through personal alerts

Also available in white

https://www.kenzen.com/

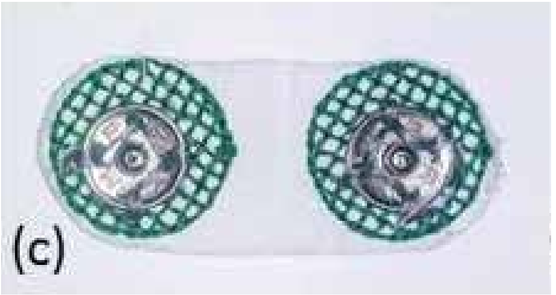
SENSOR RESEARCH

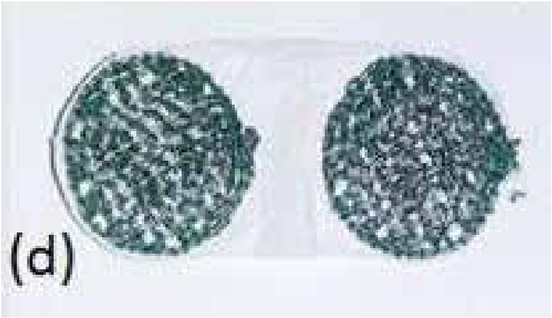
SEMG TECHNOLOGY

What is it?
A muscle fatigue prototype. A pair of running leggings with the main aim to monitor muscle fatigue

How it works
Electrodes cover the inside of the wearable which can then monitor the electrical activity of the nerves below the surface of the skin. The sensors connect to a portable Arduino microprocessor and linked up to a removable 7.5 volt rechargeable battery.

Point of interest
- User testing shows accurate recording of data
- Only monitors muscle fatigue
- More of a smart fabric/wearable than previous monitors and devices
- Developed for runners, but potential for application in other sports
- No development of an interface to display the data





https://www.technologyreview.com/s/600908/future-wearables-intelligent-leggings-measure-muscle-fatigue-in-runners/
https://blogs.mathworks.com/headlines/2017/04/18/this-wearable-tech-monitors-runners-muscle-fatigue/

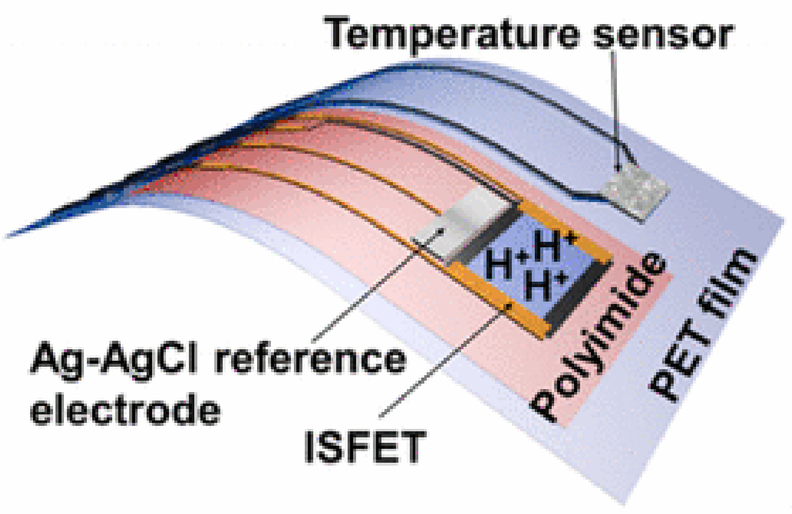
SWEAT PH & SKIN SENSOR

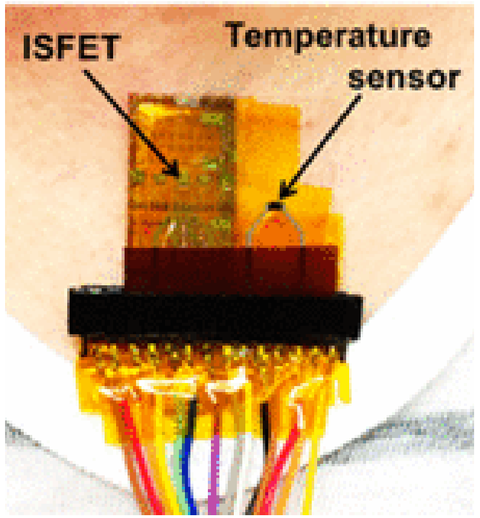
What is it?
A wearable flexible chemical sensor sheet for simultaneous sweat pH measurements, as well as skin temperature.

How it works
Upon skin contact, both skin temperature and sweat pH are conducted and measured in real time. The sheet combines an ion-sensitive field-effect transistor (ISFET) with a simple temperature sensor.

Point of interest
- This single sensor monitors two of the most important factors of muscular cramp. This type of technology would be vital in our product.

- The sheet would be able to feature as integrated patches in our shorts. The shorts hide the fact it is a patch, and provides the user with a seamless interaction.



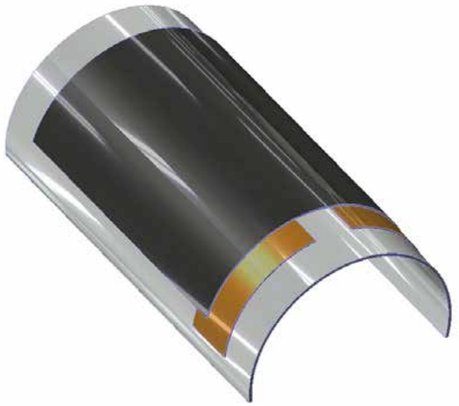


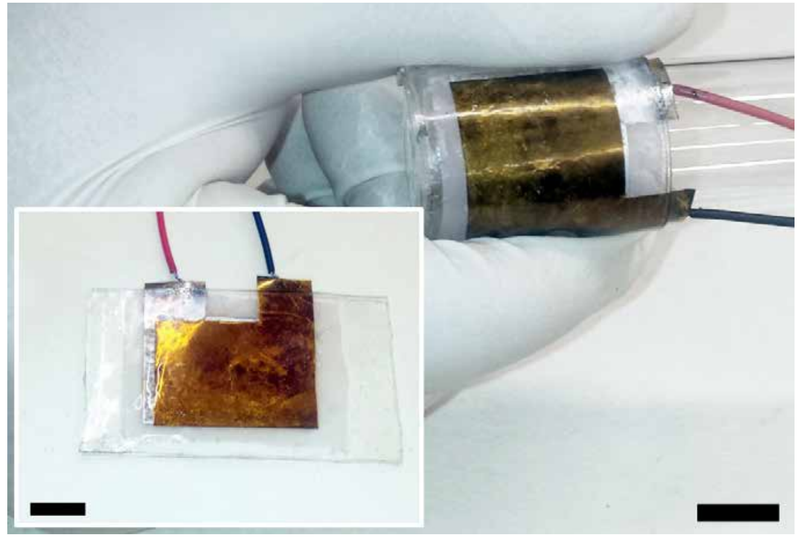
http://pubs.acs.org/doi/pdf/10.1021/acssensors.7b00047

REUSABLE KINETIC BATTERY

What is it?
A reusable kinetic battery is a type of battery that allows for rechargeable capabilities, but can also be charged through kinetic energy. For example, if someone is running and a friction is created between the battery and the user, for example, the energy created from the friction can charge and power the battery.

How can we use it?
This is really good for us because, as it's application will be in sport, the user's athletic movement should power the battery. However, if this is not the case, the battery can be removed and charged through a regular socket to give it a little extra boost.





http://fortune.com/2016/01/08/bendable-battery-smartwatch/

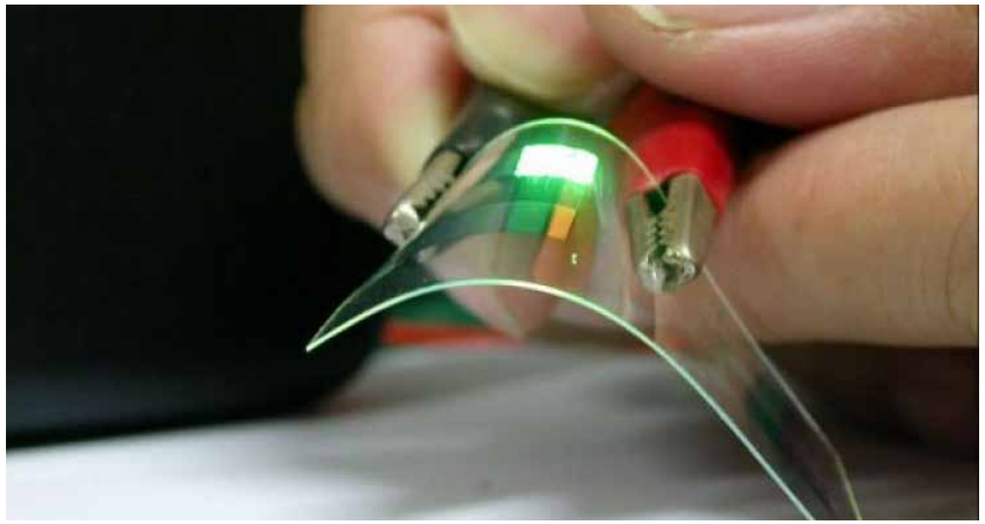
PRINTABLE OLED

What is OLED?
OLED – Organic Light-Emitting Diode – is a type of display technology that makes it possible to reach dark black levels from ultra-thin screens, while at the same time making products such as TVs more efficient and eco-friendly. Here's how OLED technology works: an organic, carbon-based film is placed between two conductors and, when an electrical current is passed through, it emits light.

With an OLED panel, the organic pixels are self-emissive, which means they generate their own light - and so can become pitch-black when turned off.

How can we use it?
With the latest progressions in technology, we are not able to print OLED's on to piece of material. The work the same way as regular OLEDs, but are a printed item rather than used in products like TV's or smartphones.

By using OLEDs in our product, it enables us to create a fully flexible garment without limited the user of any movement. As for the interaction, because the blacks of OLED are pitch black, this means that when no colour is being shown, the shorts look like regular shorts and won't distract the user.



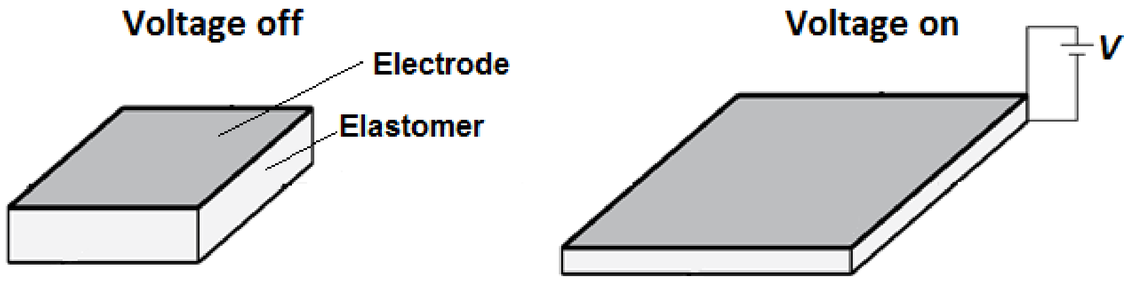
SMART ELASTOMER

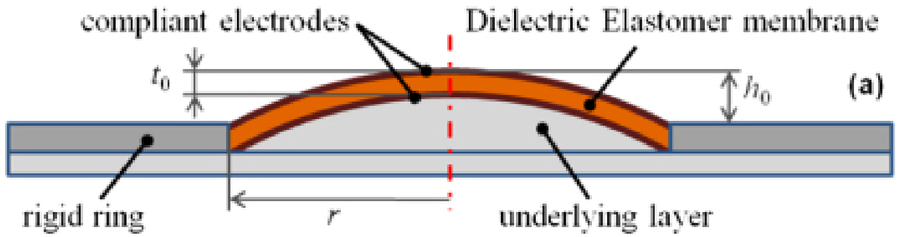
What is it?
Smart elastomers, more commonly known as Dielectric elastomers (DEs) are smart material systems that produce large strains. They belong to the group of electroactive polymers (EAP).

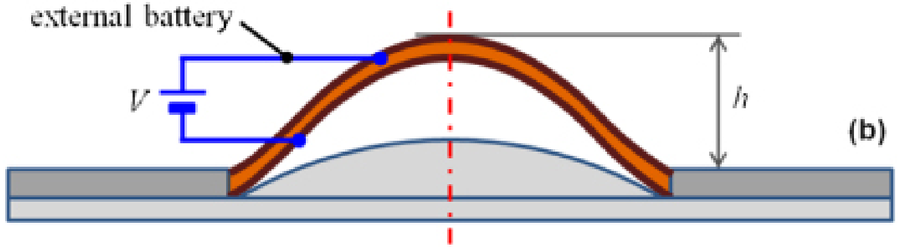
DE actuators transform energy in to mechanical work. They create movement when a voltage is passed through them. When a voltage is passed through, the actuator expands. On the opposite way around, when a movement is made by the actuator, a voltage is created.

How can we use it?
Smart elastomers are a great way of monitoring any muscle twitches or strains in the user's leg. Measuring twitches in the muscle is the most effective way of monitoring any signs of cramp, and combined with the other factors, it should help to create a solid evaluation.

In practice, the elastomer will be woven in to the fabric of the shorts and when a muscle twitches, a voltage is sent to the on-board processor and is used to create a rounded measurement of the user's cramp in conjunction with the other measurables.







FULL TECH SOLUTION

THE MEASURABLES

SWEAT PH LEVELS

The ISFET sensor allows us to measure the skin's pH content. With the optimal skin sweat pH between 4 and 5.5 on a 0-14 scale, we can create a threshold for acid levels. Any reading below 4 on the pH scale will begin the reaction process.

SKIN TEMPERATURE

As regular skin temperature is based on your environment, there's no threshold that we can monitor. Therefore, we measure anything above 35 degrees Celsius as a trigger point.

MUSCLE MOVEMENT

Being an athlete, your muscles are always moving so we are looking for any long and involuntary contractions within the muscles. When the elastomer material flexes in the shorts, the stretch is measured and converted to a voltage. These are monitored alongside the other measurements to create a more established reading.

TECHNICAL PROCESS

USER	SENSOR	REACTOR	PROCESSING
The wearer exercises with the product	The sensor simultaneously measures pH and skin temperature	With a measurement range, the OLED strips pick up data and change colour accordingly in specific area	An on-board processor takes the pH & temperature value and converts them in to a scale from 1 to 10
The wearer exercises with the product	The ultra thin elastomer woven in to the fabric collects muscle contraction data	A stretch on the elastomer sends a voltage to the on-board battery	The battery processes the voltage signal

The 2 values are cross correlated by the processor and transmitted to a mobile app

Both rows represent a simultaneous process to come out with a final evaluation

PROJECT BRANDING

OUR MISSION

Sometimes your body and your brain don't communicate effectively during exercise. You push your muscles to their limits, and with factors like adrenaline and fatigue, sometimes you aren't aware of the damage you can be causing.

Our mission is to reveal to the user, at that present time, as well as afterwards, exactly what is occurring inside the body. We want to project activity from the 'internal' to the 'external'.

For these reasons, we introduce **Exo**.

OUR BRAND VALUES

NON INVASIVE

PREVENTION, PRECAUTION, REHABILITATION

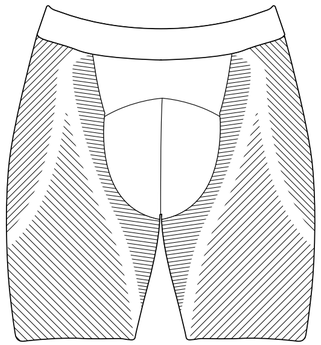
MUSCULAR CONDITION

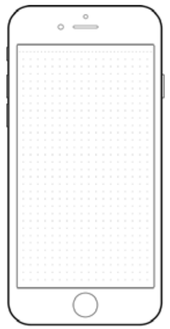
OUR PRODUCTS & SERVICES

Our whole brand is primarily based around the seamless wearable shorts. These shorts send and receive data from the processing application, where users can reflect on their physical performance and muscle condition.

Our main application is a standard Exo service, for the amateur user to use as a personal tool.

An additional service would be Exo pro. Here we would provide professional teams with seamless monitoring systems that don't distract players, and allow coaching and medical staff to make advised and important tactical decisions.





exo

Personal Application

- Reflective tool
- Shows muscle activity at different times
- Offers help, guidance and advice to improve muscle condition.

exo pro

Referee Smart Watch

- Provide real time summary of injury.
- Affected player, area, severity, time elapsed

Real time Staff Application

- View all players activity instantly simultaneously.
- Highlight any players at risk

LOGO

With the name Exo confirmed, we needed a logo to reflect our product, service and values.

There needed to be a fine balance between aggression and power. Something too powerful may seem intimidating and off-putting, and something too subtle may not represent the fitness industry.

We decided to stick with the lowercase typography, with a generally bold style.

There was experiments of illustrating the logo with mesh-work and netting, to signify the idea of stretchable material, wearables and the frameworks of science.

One of the main selling points of the shorts are the ‘revealing’ nature. We considered a gradient fill to represent this, however we thought colour theory would help support these ideas and values.

LOGO COLOUR THEORY

We explored different colours for the brand, and tested the kind of thoughts and feelings we might want to represent in our designs.

We decided that the orange to red gradient was a subtle solution to a completely crimson red colour.

It has connotations of the muscles, as well as aggression and physical energy.

COLOUR

Our main colour palette is made up of a vibrant orange to red gradient which is supported by either 8% black or 86% black.

The orange & red colour combination was chosen as it represents a sense of emotional intensity. It also is associated with energy, strength and power.

All of these associations are key factors that we want the user to feel when they use our product. We want them to feel energised and positive.

For any typography, we kept the colour to either pure white (#FFFFFF), or 90% black (#191919).

#E9514B
R:234 G:81 B:76

#DA1D4C
R:219 G:29 B:77

#EBEBEB
R:235 G:235 B:235

#262626
R:38 G:38 B:38

TYPOGRAPHY

EE

MONTSERRAT

Montserrat Bold is our title font.
We intend to capitalise each title to connote ideas of power and aggression associated with sport.

Ee

Open Sans

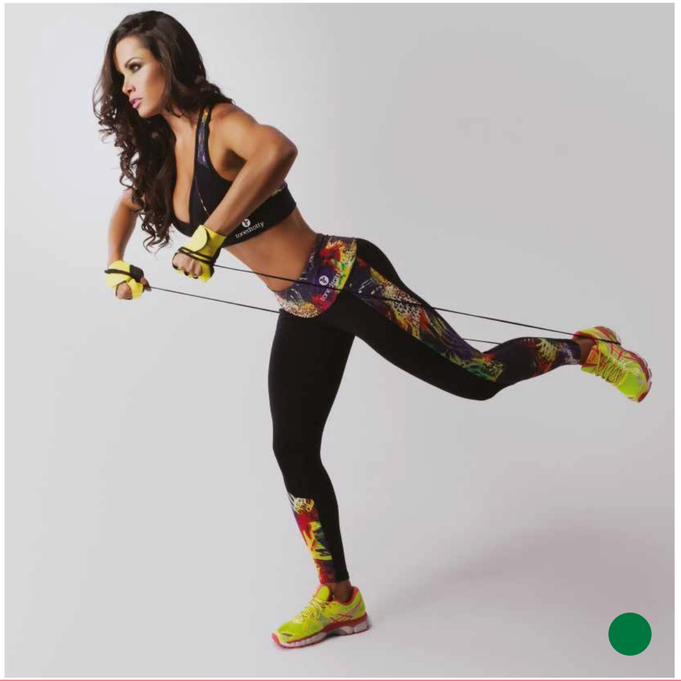
Keeping with the modern style, Open Sans offers a smart and functional body copy that is stylish too.

IMAGERY

The imagery used for the Exo brand is energetic and professional photography. It needs to have a sense of movement and agility.

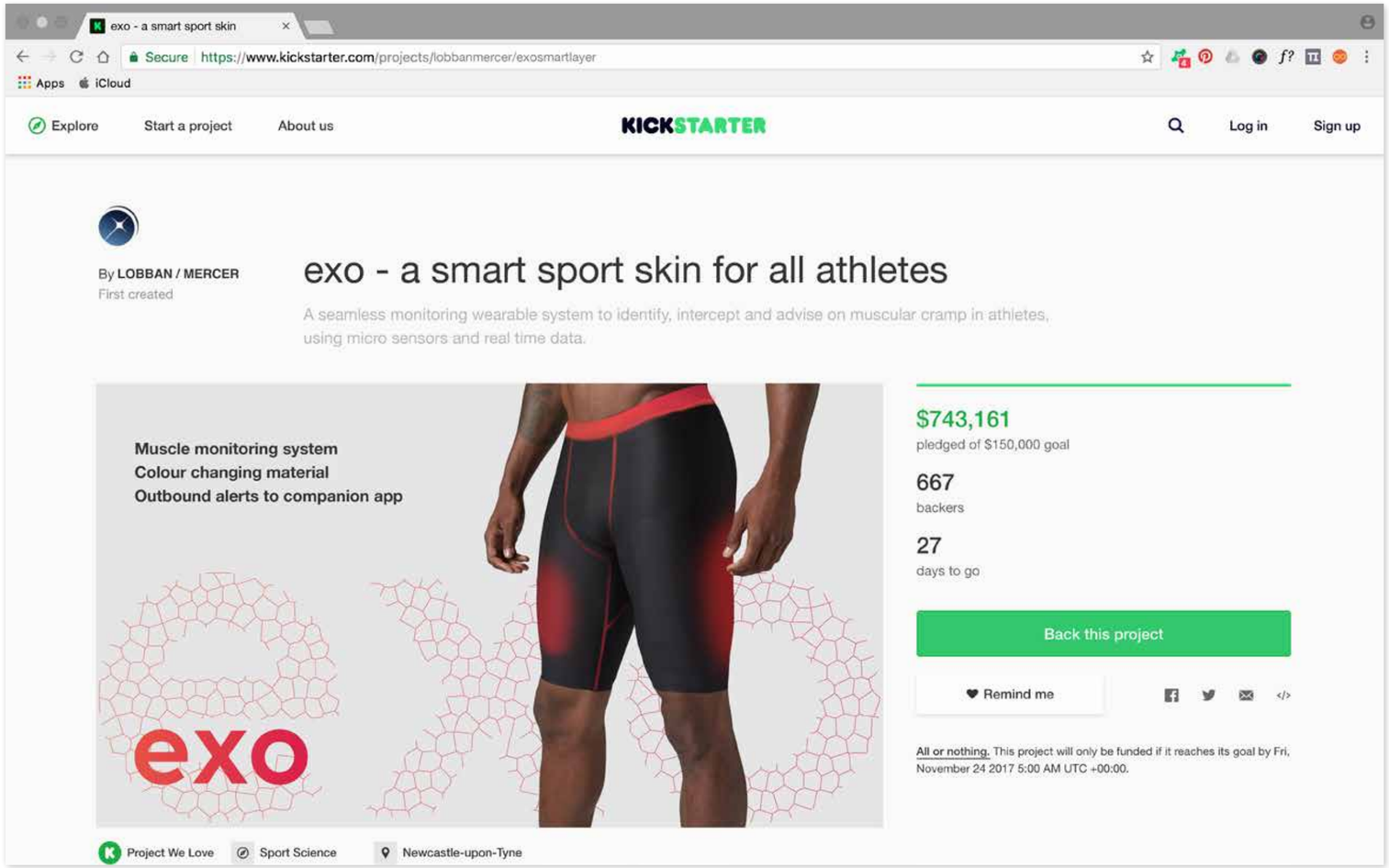
The images should have a person in focus with the background blurred, like a bokeh effect. There shouldn't be a mass amount of colour coming through from the background, and the main person in focus shouldn't be a silhouette.

Finally, cheesy imagery should not be used. Basic stock imagery that doesn't represent the fast paced theme of the brand should not be used.



- *Green circle indicates a good image*
- *Red circle indicates a bad image*

KICKSTARTER MOCKUP



Design Fiction was a useful way for us to quickly summarise our project and apple our brand to the materials we made.

From here we could see how the product may look amongst other competitors and start ups.

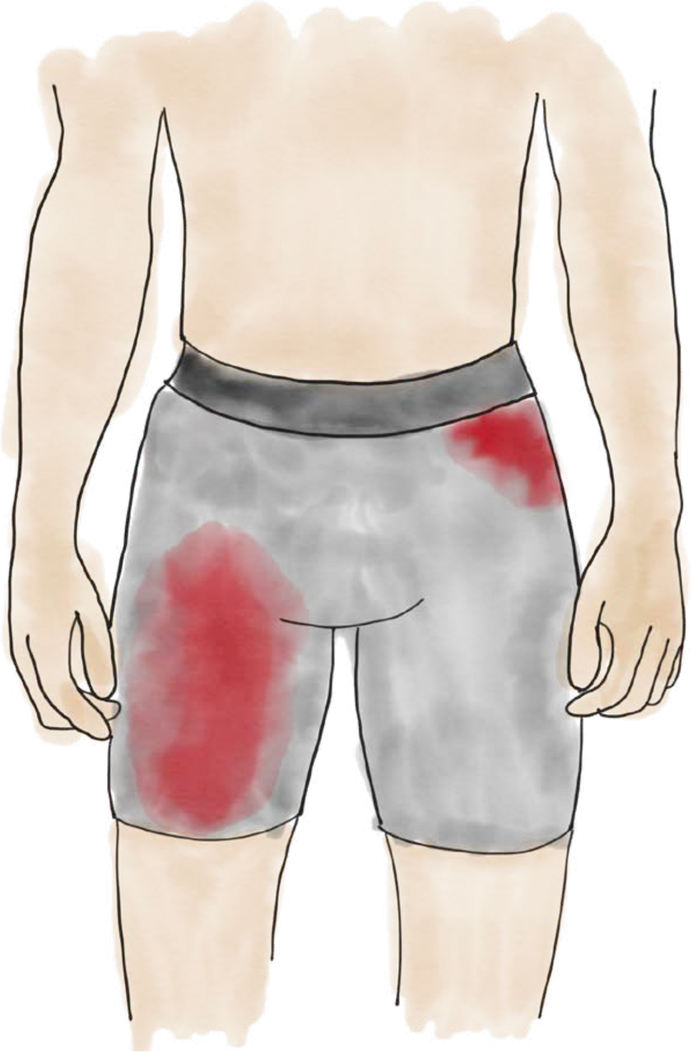
It also provided us with a realistic concept to receive important feedback .

WEARABLE DEVELOPMENT

SHORTS DEVELOPMENT

GLOW CONCEPT

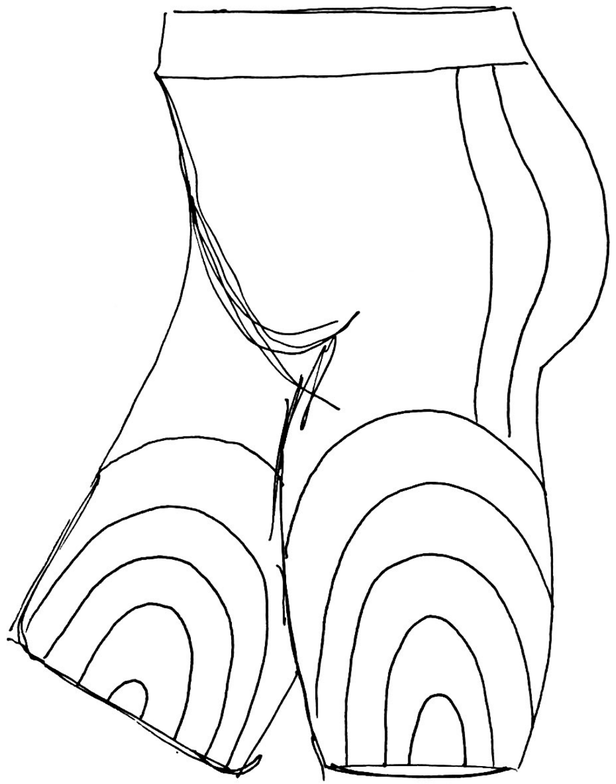
Initially, we wanted to highlight the specific muscle that was triggering the sensors. We thought the best way to do this would be through a colour change. However, gathering feedback, we realised this proposed visual indication could look quite alarming, as it could be mistaken for blood.

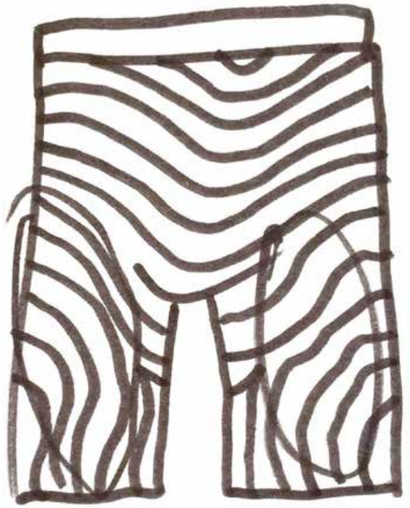


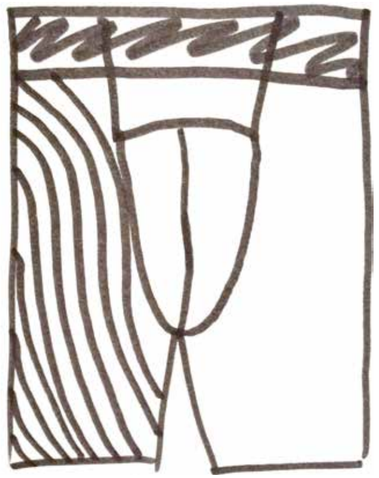
SHORTS DEVELOPMENT

PATTERN AREA

We didn't want to disturb the athlete with sound alerts, vibration or heat. We feared they may panic and worry the player. We decided a non-fluid like colour change would work better. By brightening a pattern, we could stylishly display the effected area.





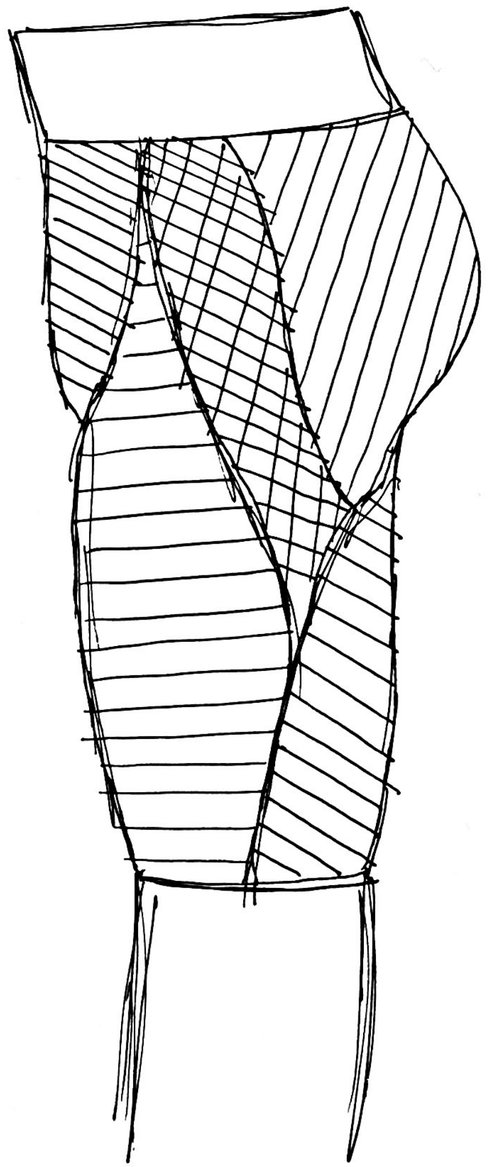


SHORTS DEVELOPMENT

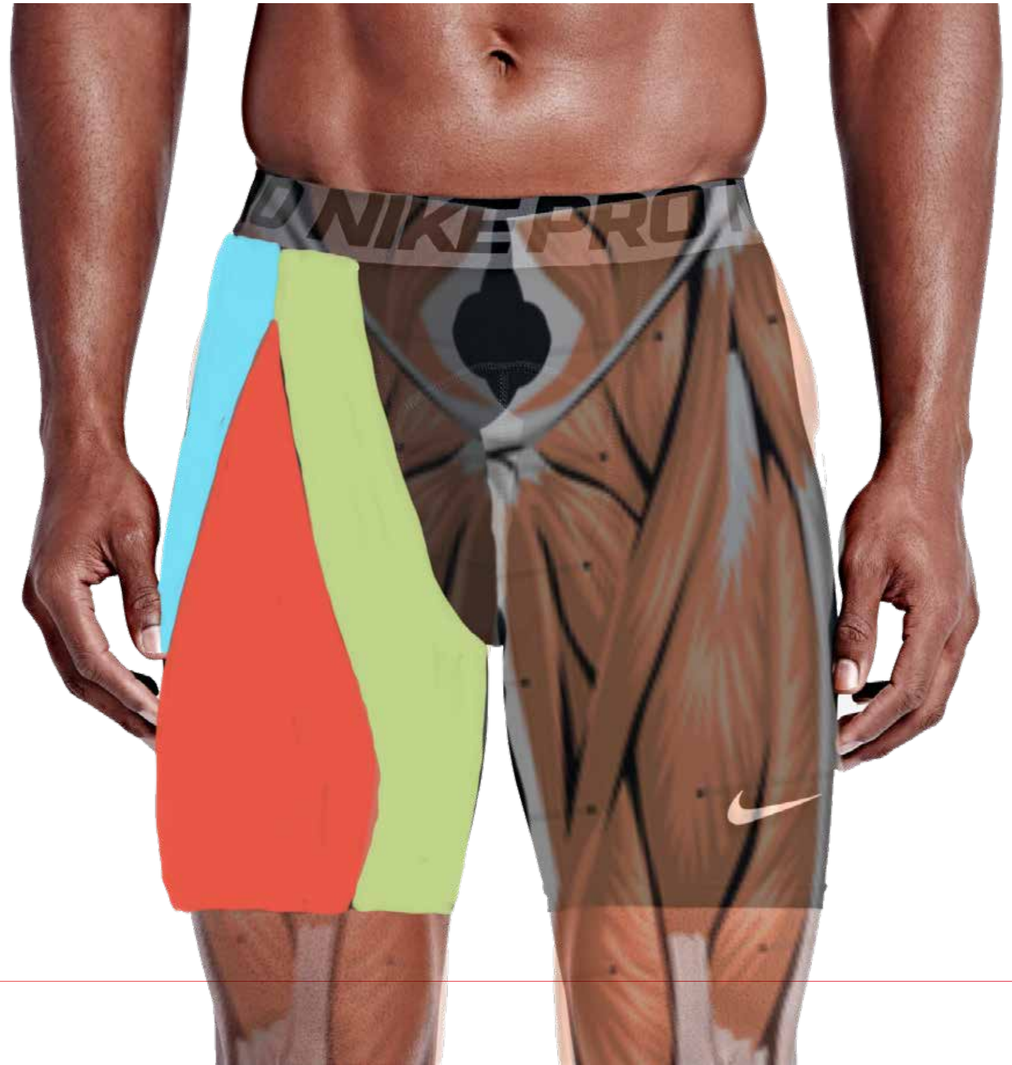
SHORTS DEVELOPMENT

MUSCLE PATTERN AREA

The pattern concept wasn't alarming and effective, which was an improvement. . However, instead of just a visually cool and 'slick' pattern, we realised we had the potential to trace the muscles. We decided to section the patterns off, and created contrasting areas for easier detection. This stuck to our EXO brand, and this idea of bringing internal muscle activity onto the surface of the skin.



SHORTS DEVELOPMENT



FINAL SHORTS

10% Elastene / 90% Polyester

Woven stretchable elastomer throughout each muscle area with printed OLED ink.

Embedded ISFET Chemical Sensor within each muscular area

Exo branded waistband houses the colorimeter and battery

TECHNICAL SPECIFICATION

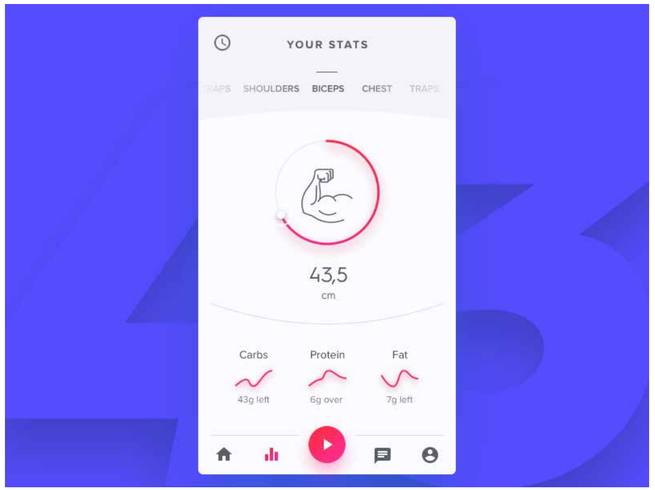
1x	Compression Shorts - Including woven elastomer - Including printed OLED ink	£20
10x	ISFET Sensor	£20
10x	Smart Elastomer Strips	£20
1x	Processor	£5-£10
1x	Battery	£10
Unit Manufacturing Cost		**£80-100**

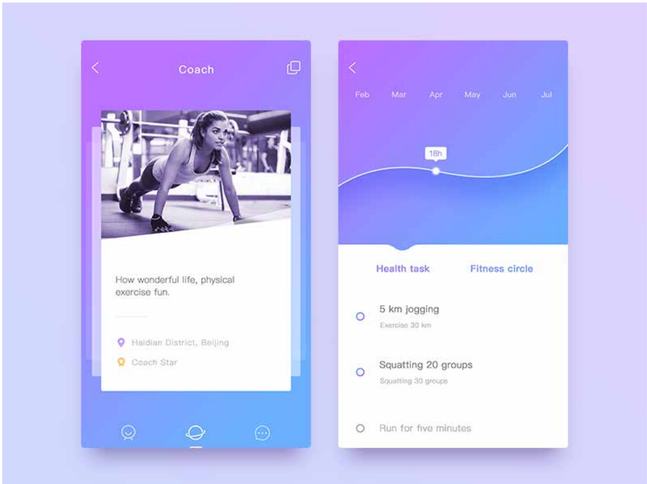
APP DEVELOPMENT

VISUAL INSPIRATION

When looking at inspiration for the app, we liked the look of existing apps that weren't too busy and utilised empty space. The use of space allowed the eye to focus on the areas that the designer wanted you to look at. In the case of the design for our app, we wanted the user to focus a lot on the infographics and statistics, so these were the elements we mostly took inspiration from.

Using different websites that displayed different UI designs, we could also get a feel for how the app would function with micro interactions and page transitions.



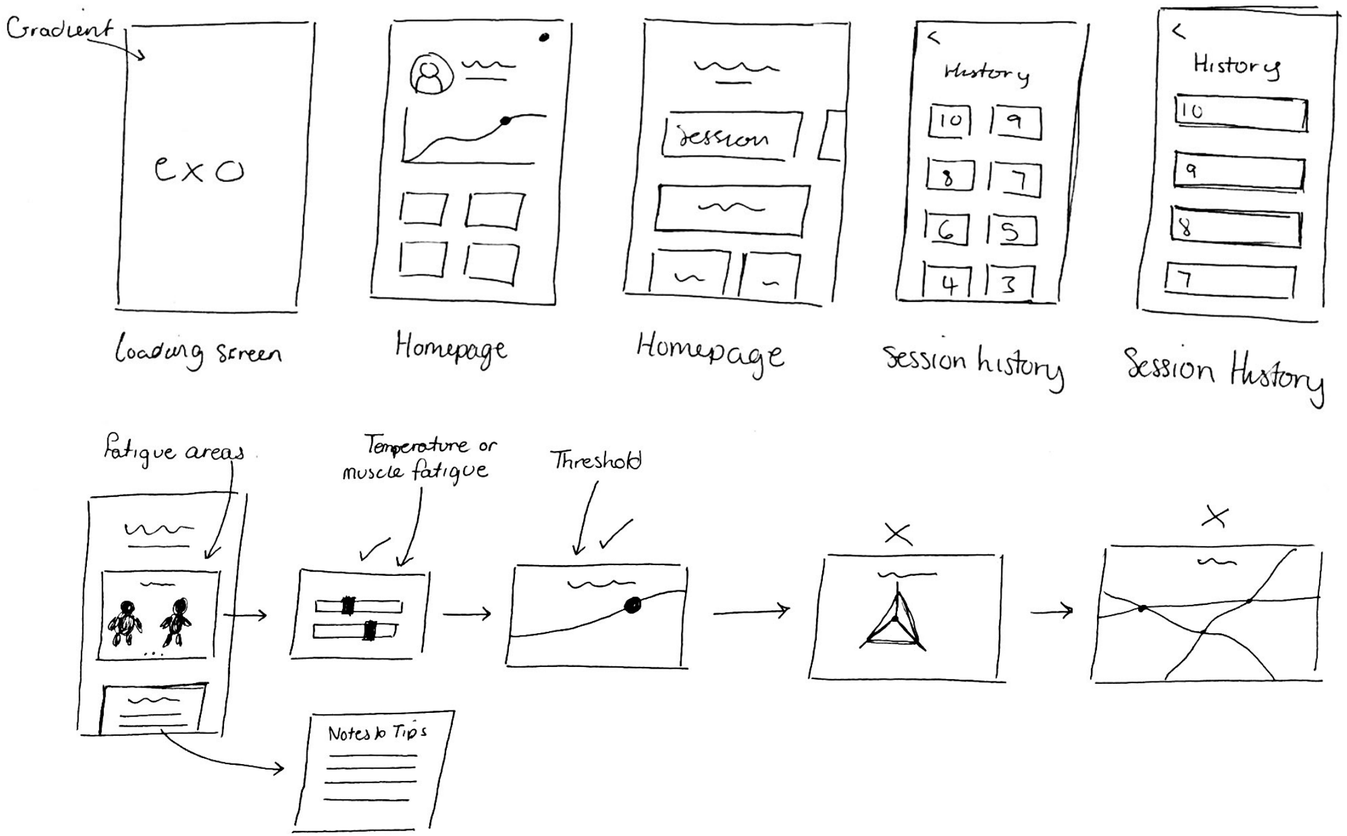


WIREFRAMES

The wireframes were helpful to get a sense of what kind of information we needed to prioritise on each screen. For example, on the homepage we wanted a button to quickly view your current session as well as quick links to each other main page.

For the main sections of our app, such as the session view, our content was up in the air for a while until we properly created a hi-fi mockup. However, from what we sketched, we really liked the drawings of the people as well as the information sliders and the graph. The other 2 on the end didn't really work and would've been complicated to prototype properly.

Another feature we liked was the notes & tips at the bottom of the individual session page. This was a set of tips relative to that session and would be created based on the injury that the person had picked up.



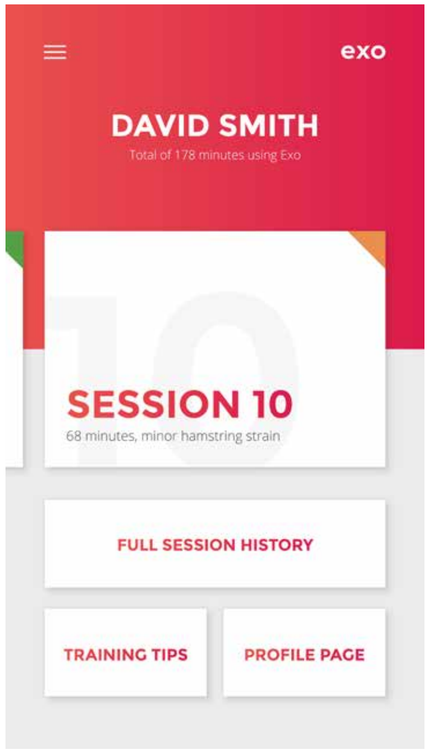
HI FI MOCKUPS

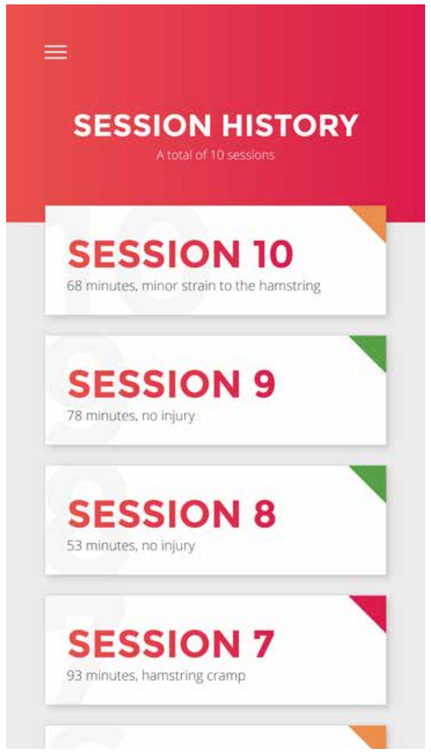
Overall, we're really happy with the look of the app. It looks modern and slick, but most importantly it functions properly. It is designed so that the user can quickly navigate through the different screens.

Homepage
The homepage features a horizontal slider to navigate through the most recent sessions with the ability to click through to that session's page. It also has quick buttons below to go to other top level pages.

We have incorporated a traffic light system for the injuries that the user picks up. No injury is a green colour, a minor strain is orange and a more severe injury like cramp is red. This is an easy way for the user to identify which session he had issues.

Session History
A simple list of all of the sessions in descending order from newest to oldest. Each session takes up the full width so the user can quickly identify that session and see details of that session.



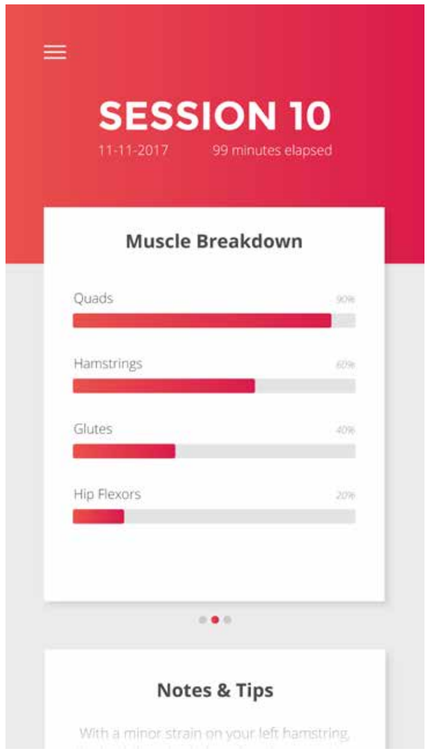


HI FI MOCKUPS

Session View - Fatigue Areas
Fatigue areas is a quick and easy way for the user to see the areas in which they may have strained or injured themselves. They can also quickly identify, by colour, how severe the injury is.

Session View - Muscle Breakdown
The muscle breakdown is an infographic way of displaying data for all of the main muscle groups. it use a bar graph-like way of showing the data as well as a percentage reading on the right. The percentage is worked out by processing previous data and finding a threshold maximum for each muscle group before it gets cramp and using that as the 100% value.

Session View - Conditioning Threshold
This graph shows the point at where you go beyond your own threshold for performance. The X value is the time, and the Y value is the threshold created by triangulating the 3 different measureables (pH sweat levels, temperature and involuntary muscle movement). The red shows the point in which you have passed your “comfortable” area and are risking injury.



FLINTO PROTOTYPE

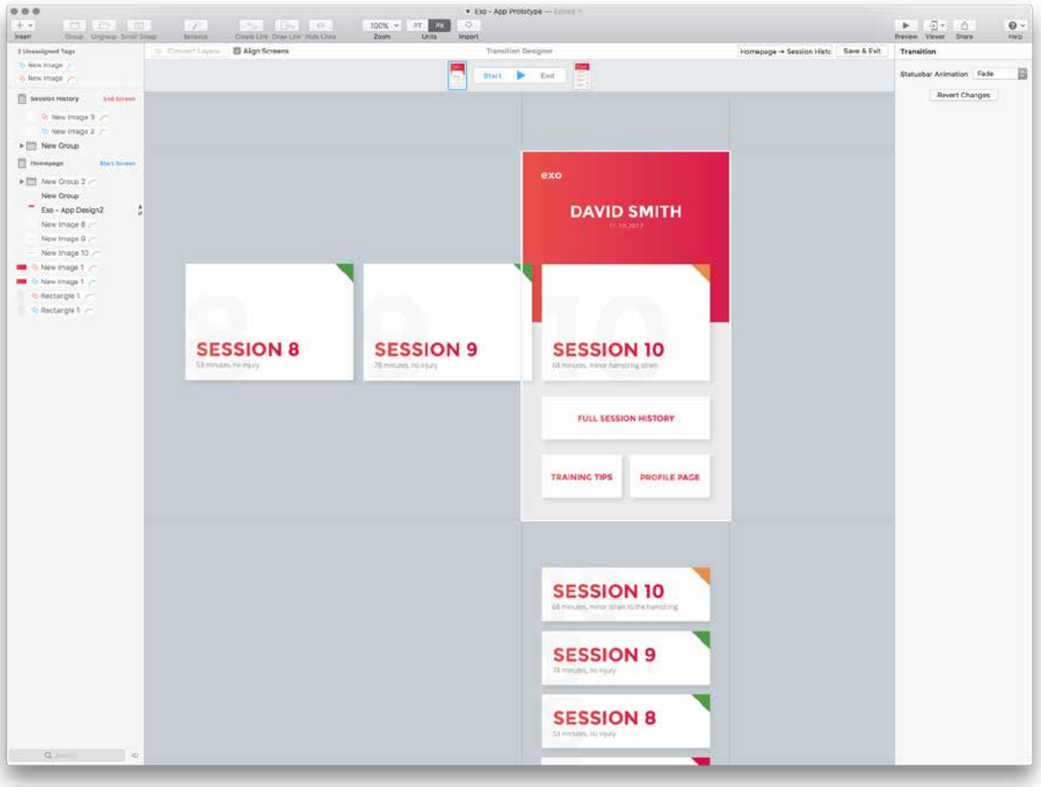
After using Flinto in previous projects with great success, we decided to use it again. Flinto is a prototyping application for creating interactive applications. Its really effective for creative page transitions as well as micro interactions for elements on a page. For this project, we used Flinto to demonstrate the mobile notifications as well as the main app.

For the mobile notifications, each notification was imported and animated on a time delay. We tried to recreate the same animation that is used on iOS where it appears from small and nudges the previous notification down.

For the main app, we wanted to make function of the scrolls, both horizontal and vertical. On the homepage there is a horizontal scroll for the sessions. This was a good example of how extra information could be hidden off the page and be shown through a swipe. To create the scroll, we created a “behaviour” from the different sessions and created a “state” for each session. The whole section moved across 1 session per swipe.

For the vertical scroll on the “session history” page, we added a slick scroll transition where the header elements moved to a smaller formation as you scroll down the page. This created a really nice effect and allowed the header content to still be visible but take up less vertical space.

Finally, for the page transitions, we wanted to incorporate a smooth & connected movement for the elements. For example, some elements that stay the same when moving to a different page, such as the background colour gradient and the logo, would just simply move to their new location without having to have them move off the page, then back on. This was a great way of making the app feel professional and allowed the user to feel like they were on a proper journey of the app as opposed to a stop and start, basic app.



VIDEO DEMO

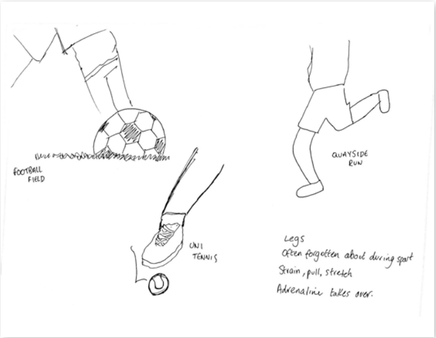
STORYBOARD

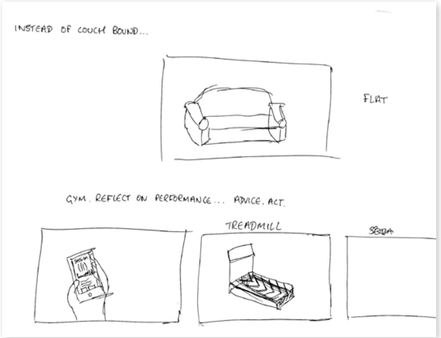
We had to tell the story of our project in a clear way for the user to understand the technology behind it, the benefits to the user and the useful features of our application.

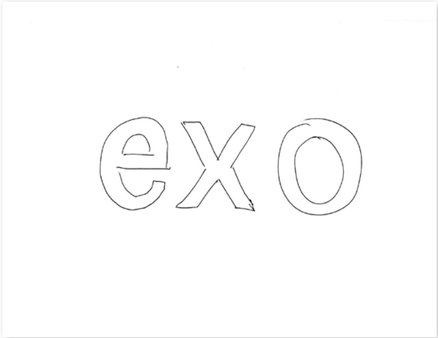
Rough sketches allowed us to storyboard a template for the demo. By restricting illustrations to one page per shot/scene, we were able to change the order until our story made sense.

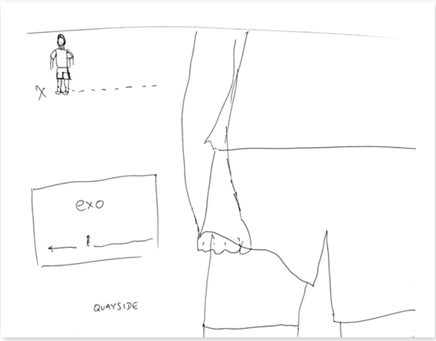
A logical order was decided on.

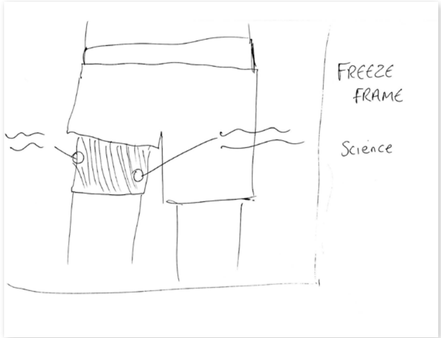
- Address issue with sport/muscle related injury.
- Introduce the brand with short overview
- Use freeze frames to explain concept and technology behind build.
- Mask the footage to make realistic design fiction
- Show benefits during exercise
- Show benefits after exercise with full application walk-through.

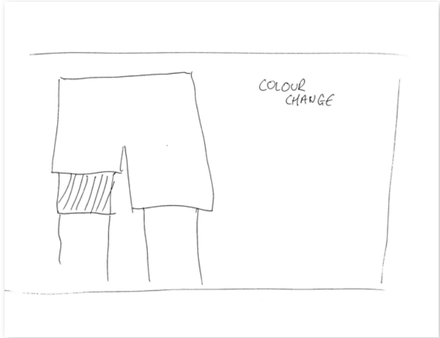


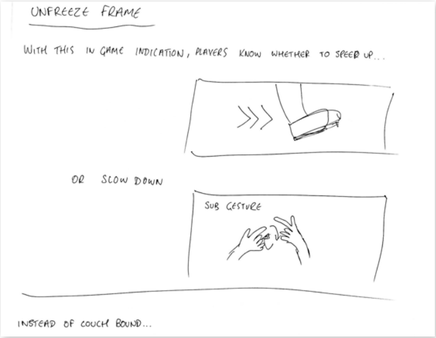


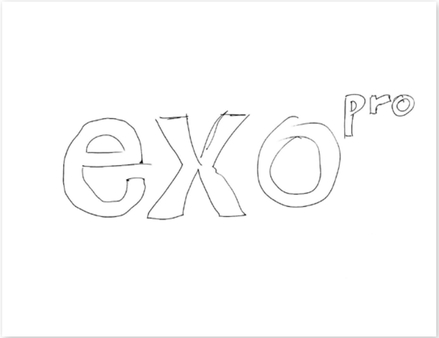


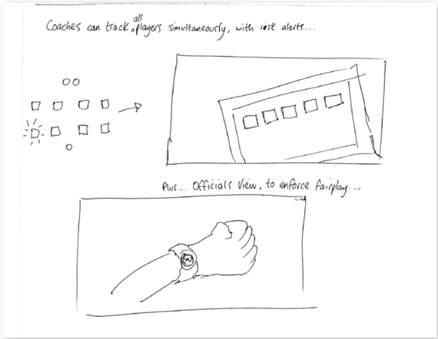












SCRIPT

Before filming, it was essential to develop a rough plan of what we wanted to say in the demo.

This was a useful reference tool because whilst filming, we could refer back to the plot, and choose different camera shots and footage to best describe each point.

We knew that this was just a rough guide, and was bound to change when it came to recording the voiceover.

Exo Advert Voiceover Script

Your legs can often be forgotten about during exercise. Adrenaline often takes over, and you don't realise when you're pushing yourself too hard.

This can result in sudden leg cramp, muscle tears an serious long term damage, which interrupts your progress and holds you back.

Or at least it did… Introducing Exa Wearables. A pair of non-intrusive monitoring wearable shorts to identify, intercept and advise on muscular cramp, using micro sensors and real time data.

Just press the small button on the waistband to begin and end monitoring a session.

With ISFET chemical sensors and smart elastomer woven through the fabric of our specialist shorts, we are able to monitor the three main indications of athletic cramp.

Skin temperature.
Sweat pH Levels.
and Involuntary muscle movement.

This data is cross-correlated onboard the short's processor.

Then they visibly glow depending on the intensity of the muscle activity, thanks to printable OLED ink. Users can then make smarter decisions. They might need to call it a day…or decide to keep pushing themselves.

After the session has ended, the data from the shorts is compiled in our mobile application. Users can view previous session details. We highlight areas of concern, a full muscular breakdown and your personal muscle conditioning time.

Smart notes & tips are provided based on that individual session, giving the user something to consider for next time.

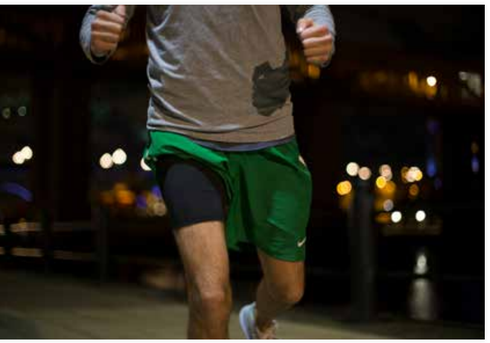
Exo. Go with the glow.

FILMING

Filming took up a full days work, from midday to around 11pm.

Initially we planned on using public football pitches to show a potential athlete user. On arrival, there were some empty 4G pitches that had a more professional look. We asked management for permission to film and they allowed us to do so.

We also decided that another point of view would be a casual jogger. Filming at night time provided use with a dark contrasting view to the product, and meant we could showcase the product in a darker light for a more impressive effect.



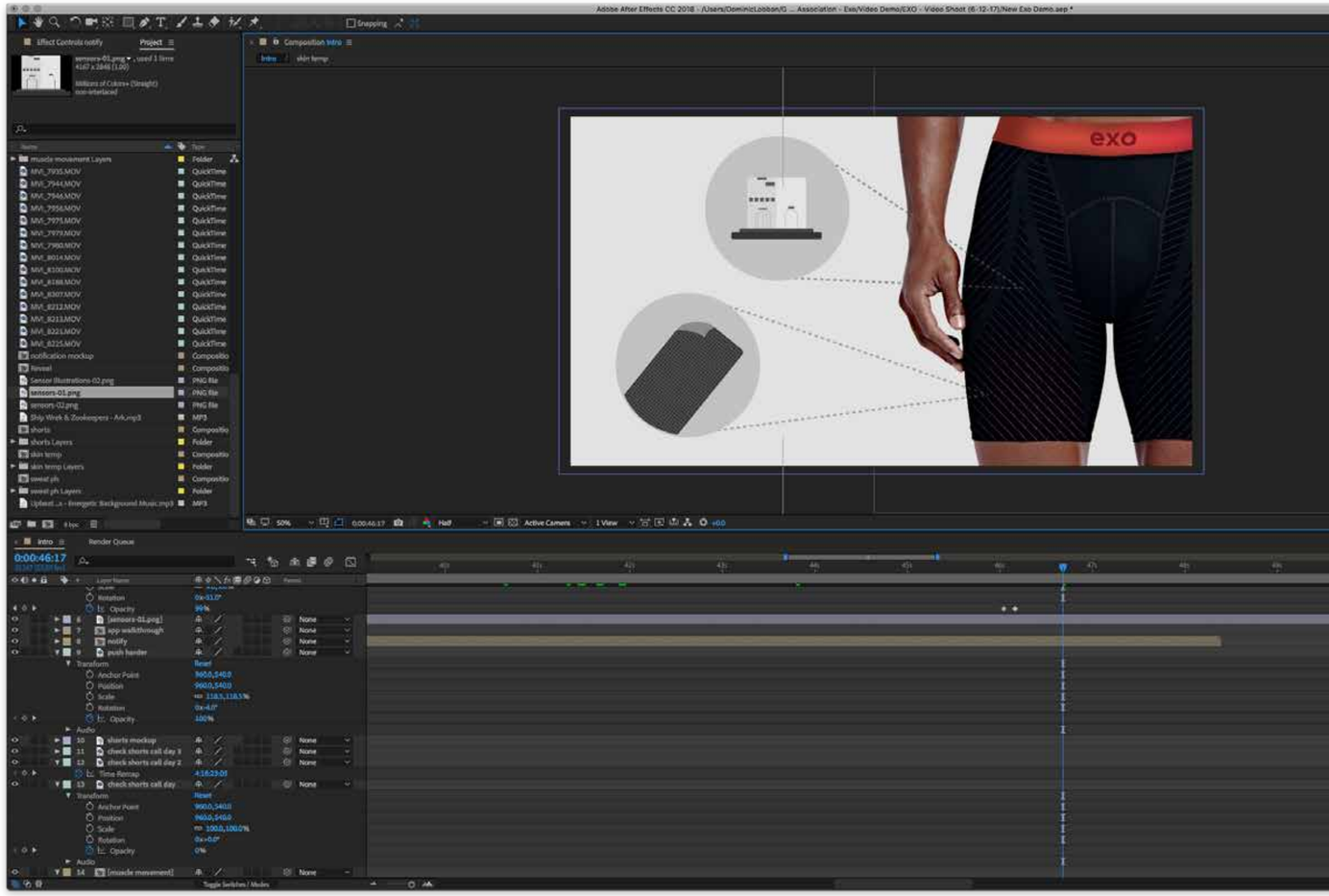
AFTER EFFECTS

MOTION GRAPHICS

We were not able to develop a physical prototype for this project. The overall cost would be far too high.

Also the technical nature of our product is quite intense. For a customer they would be a lot of technical jargon that may confuse them.

Because of these reasons, motion graphics played a key part in explaining aspects of our product. We could show the embedded technology, as well as provide visual prompts to engage the audience.

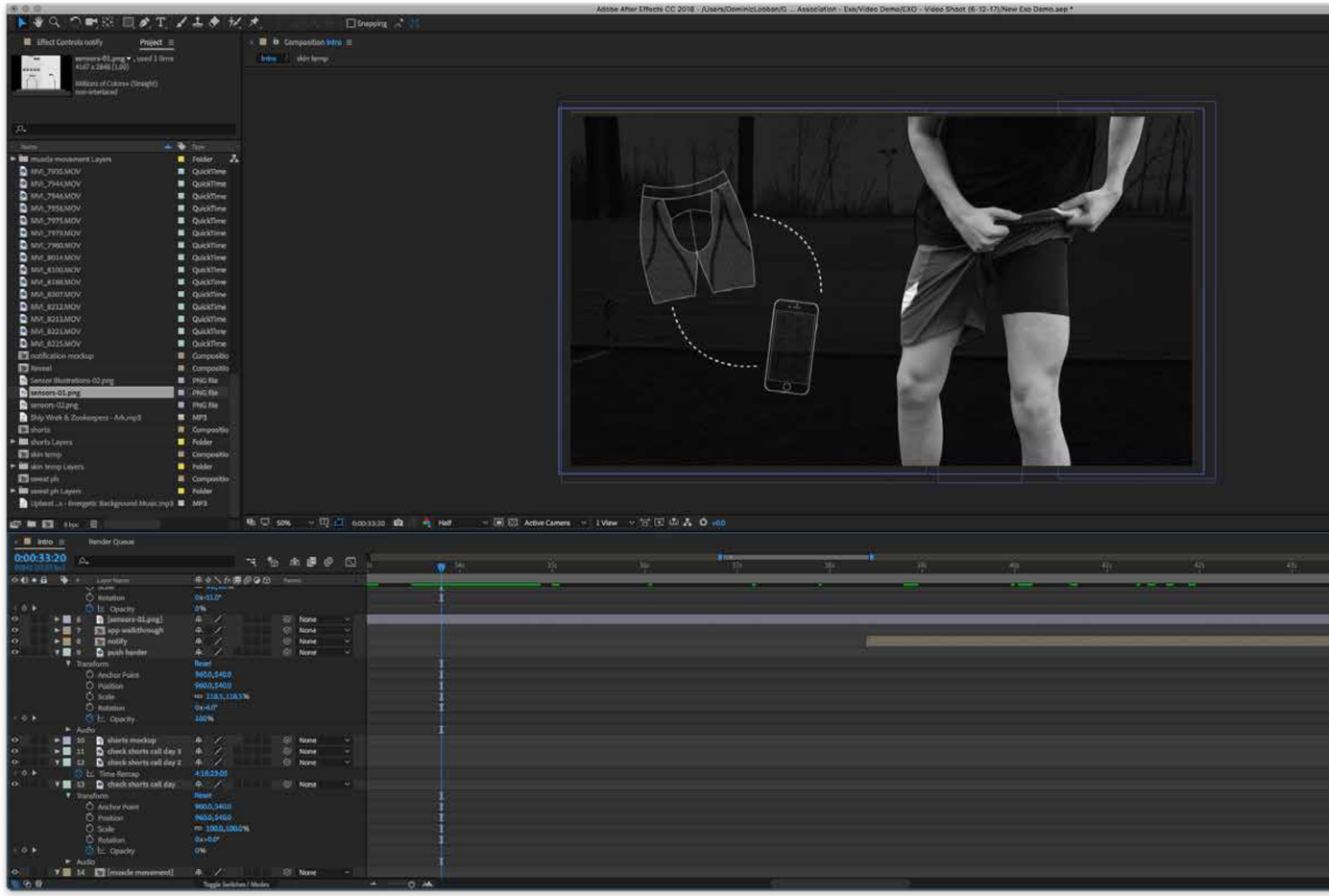


AFTER EFFECTS

FREEZE FRAMES

Freeze frames were essential in giving us enough time to really drive information home. After duplicating and splitting clips, the tool Freeze on Last Frame turned fast paces footage into a still.

We were then able to animate over the top, as well as allowing the audience to take a few seconds to take in the important information that the voiceover was providing.

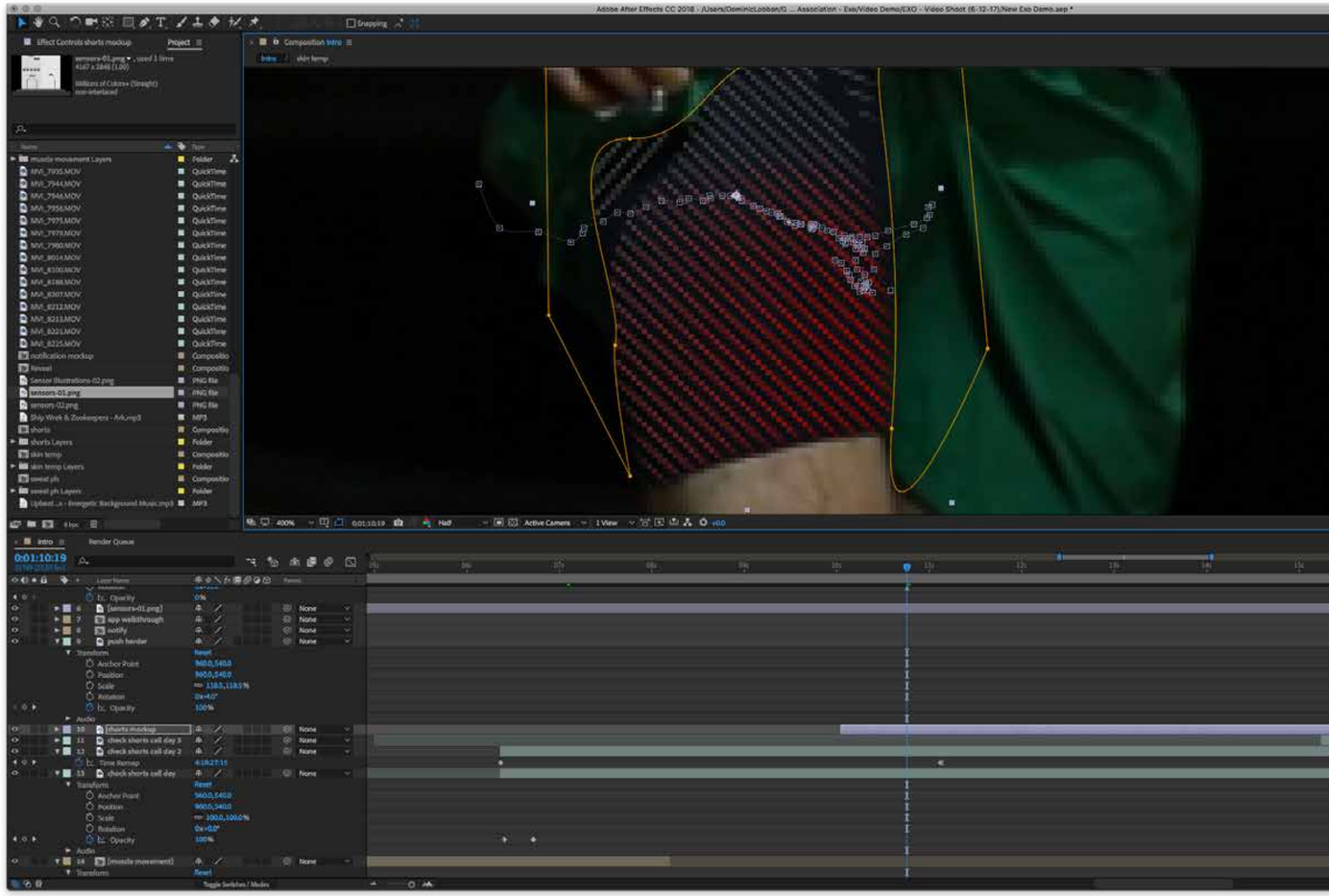


AFTER EFFECTS

MASKING

To achieve the realistic prototype animation, we had to pause the footage. After taking a screenshot, we designed our shorts visual appearance with this specific perspective .

From here, we then masked the illustration frame by frame for around 120 frames, giving 4 seconds of the shorts being revealed. Combining this with a freeze frame showcased the full product in the most seamless and subtle way.



VOICEOVER & SOUNDTRACK

When recording the voiceover, we made some key changes. Some were as simple as changing words around and replacing tricky words with simpler terms.

This ensured that timing in the video was relative to the spoken voice. In Ableton, we also turned down any popping transients that stood out from the general volume, as well as applying a generic compressor.

For the soundtrack, we decided to merge two backing tracks. One was for an energetic and fast paced introduction to grab audience attention, with the second complimenting the excitement of our product.

00:24:15
"A pair of non-intrusive [redacted] wearable shorts to identify, intercept and advise on muscular cramp, using micro sensors and real time data. "

00:33:15
Just press the small button on the waistband to begin and end monitoring a session.

00:40:00
[redacted] ISFET chemical sensors and smart elastomer woven through the fabric of our specialist shorts, we are able to monitor the three main indications of athletic cramp.

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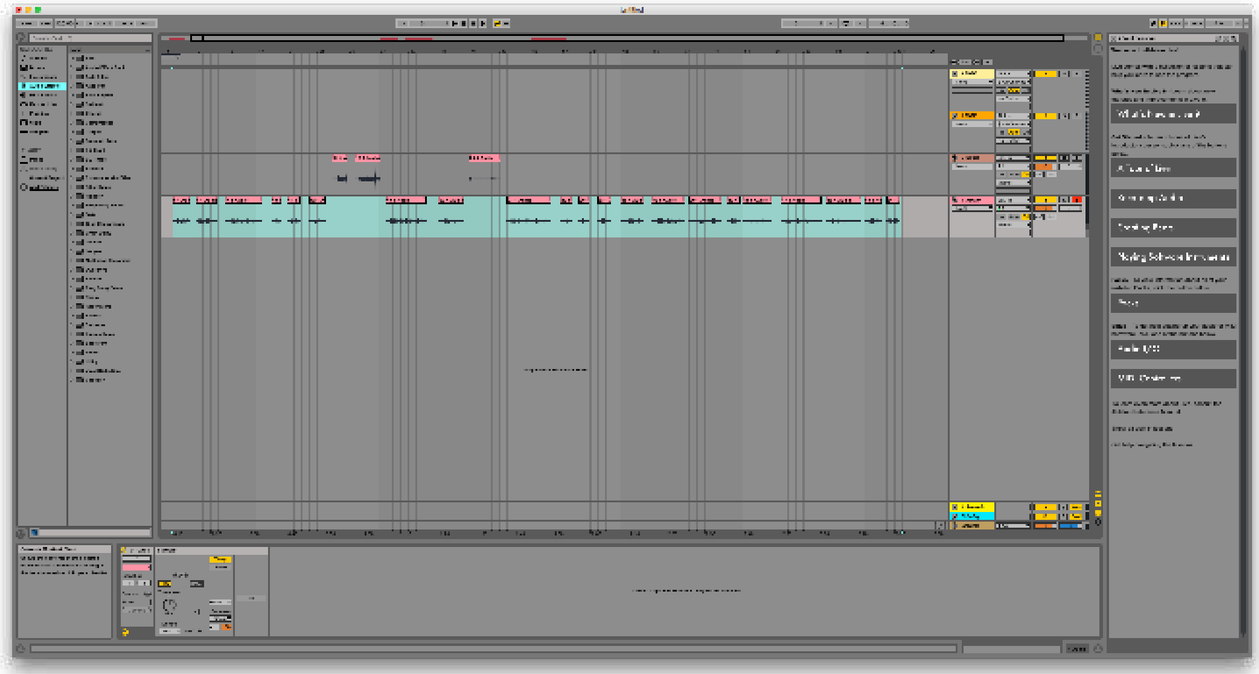


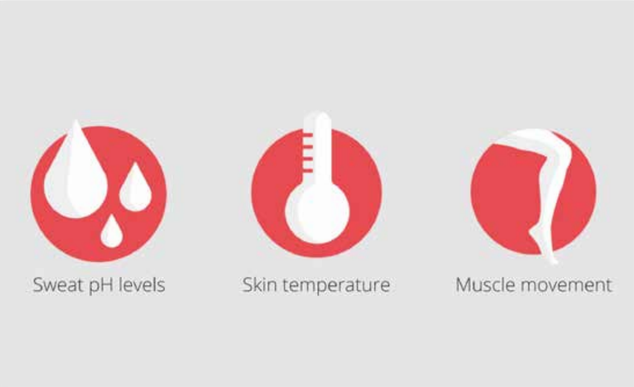
FINISHED DEMO

The final outcome intends to show the full process involved when interacting with our seamless and subtle product. The first scene uses fast editing and intense accompanying music to create excitement and interest.

We use fluid and quick animation to reflect the pace and ease associated with wearing the powerful shorts. Specialist jargon is clearly displayed with useful visual aids, as well as clear animated prototyping to demonstrate the shorts in a real user situation.

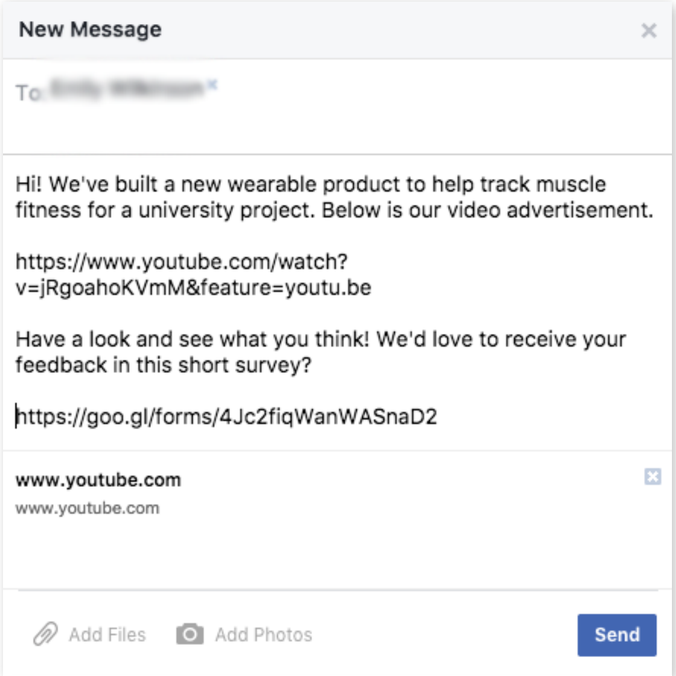
Following this, a narrated application walk-through explains the usefulness of the app, as a reflective tool. This section focuses on self evaluation and improvement.

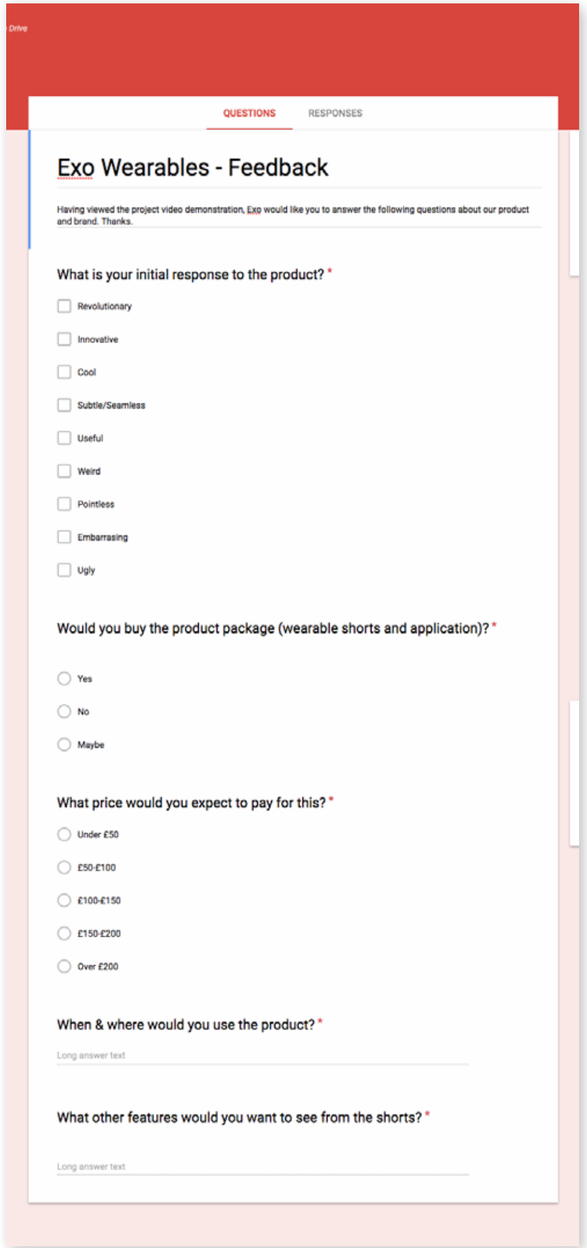
We finally summarise our brand goals with a punchy slogan.



USER TESTING

We wanted reactions to the finished demo, just to see what we could work on if we had more time. We sent out a video link and a short, 5 question survey link to our Facebook communities, sports teams and families. The aim was to get general and unfiltered responses from a range of different people, as well as our target market.





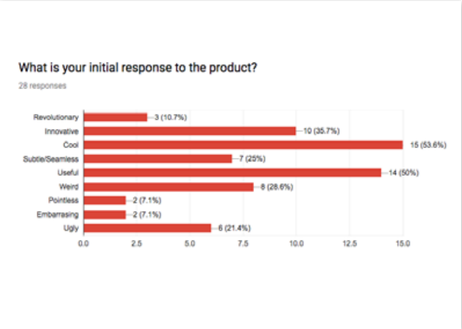
USER OPINION

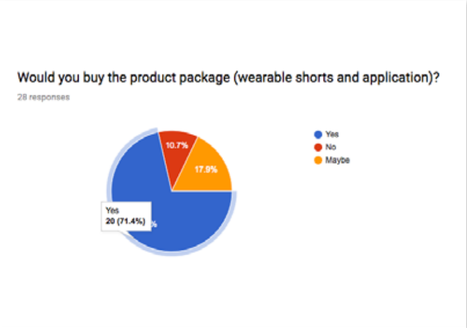
The results were very diverse. Some people simply didn't see the value in the product, potentially as they may not experience such issues when exercising, or don't exercise at all.

Others see it's value in gym and fitness environments. We believe this is down to the reflective app more-so than the onboard glowing process.

We were really curious to see a potential price for our package. Again these answers varied. Anywhere up to £100 dominated the results, with almost a third of results showing an interest in potentially higher mark ups.

Potential future features really opened up our eyes, and there were some ideas we didn't even consider. We received heat and contraction reactions for the shorts as we considered. We also received ideas such as distance and calorie tracking. One respondent wanted an online community to boast and share statistics!





COMPETING MARKET

£20-£30

Industry Standard Compression Shorts

Intended for gym and event use, made of supporting fabric for added coolness and comfort.

£30-£300

Fitness Trackers

(EG. Fit Bit, Apple Watch, Moov, Kenzen) Everyday physical devices to provide **limited and general** data to the wearer. Many apps and interfaces display data with no instant feedback during exercise.

£119

Exo Wearable Package

Equal product of industry compression shorts, with additional benefits similar to high end health trackers.

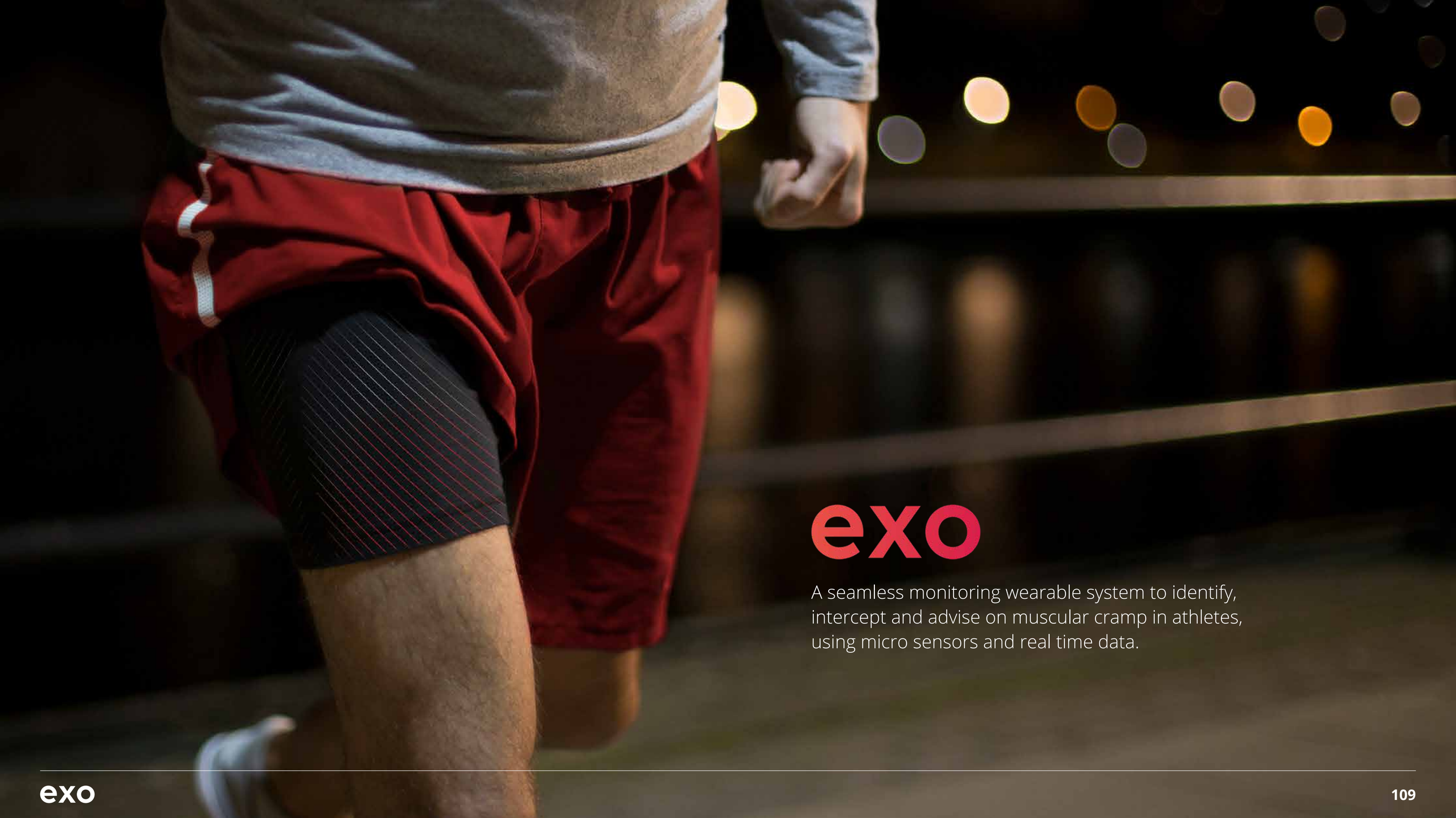
A companion app that displays information to promote safe training and improvement

£ N/A / Private Use

Professional Medical Test

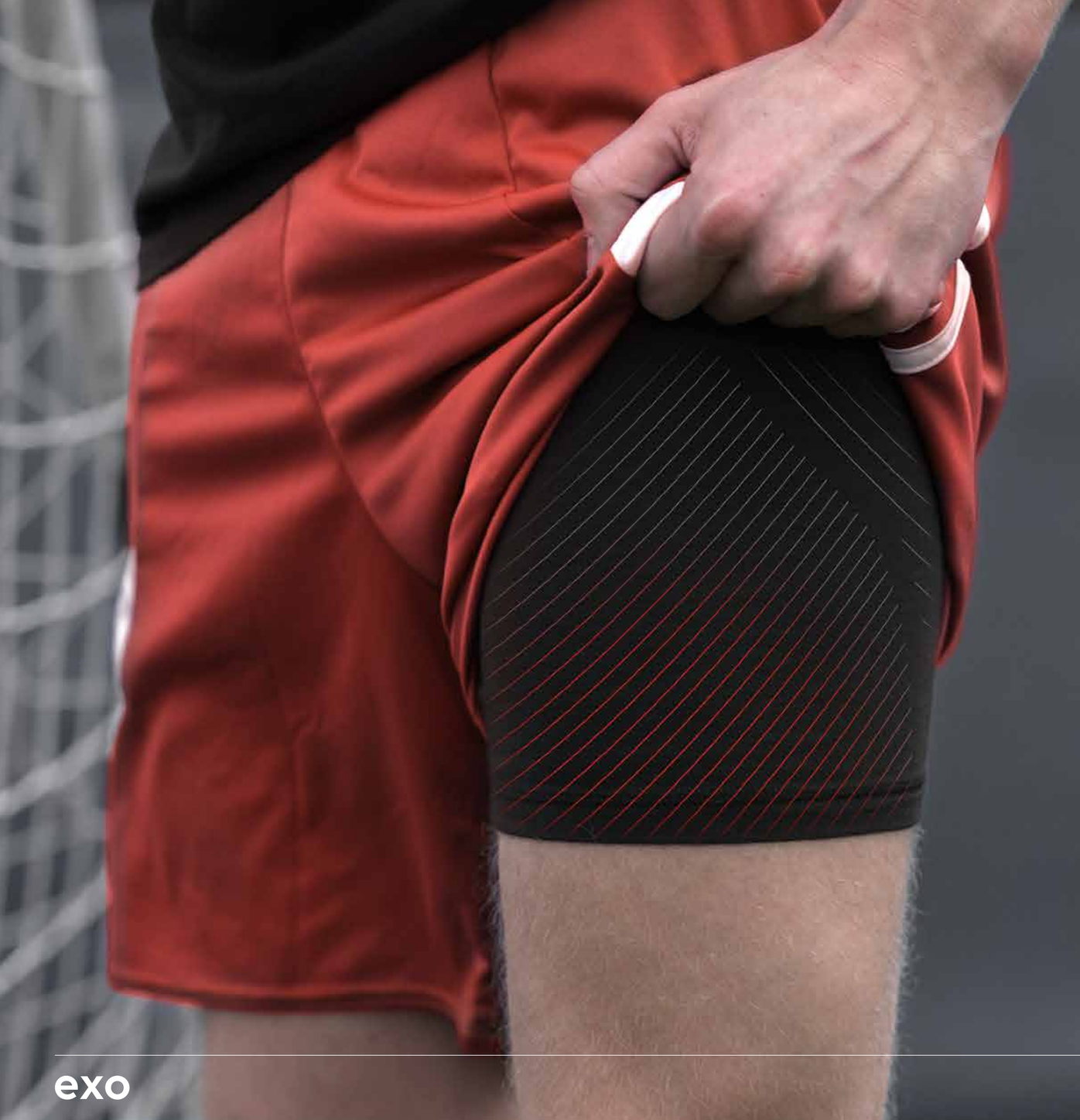
Often intense and invasive, including electrodes and patches, these are the specialist way to provide a full medical analysis. **Costs thousands** for machinery, technology and employment of staff.

PART 4: FINAL SOLUTION



exo

A seamless monitoring wearable system to identify, intercept and advise on muscular cramp in athletes, using micro sensors and real time data.



WHO ARE WE?

Exo specialise in monitoring athletes and sports enthusiasts muscle condition for them, to ensure they can relax and fully concentrate on the physical activity they are engaged in.

OUR ORIGIN

We found that muscular cramp, strain and injury pose a serious issue in sport and fitness, whether you are the elite professional or the amateur enthusiast. We are just as concerned at providing an instant indication to muscle condition as we are to providing a reflective tool, which is what makes us stand out from the rest. This ensures you can make quick, informed decisions on how far to push yourself.

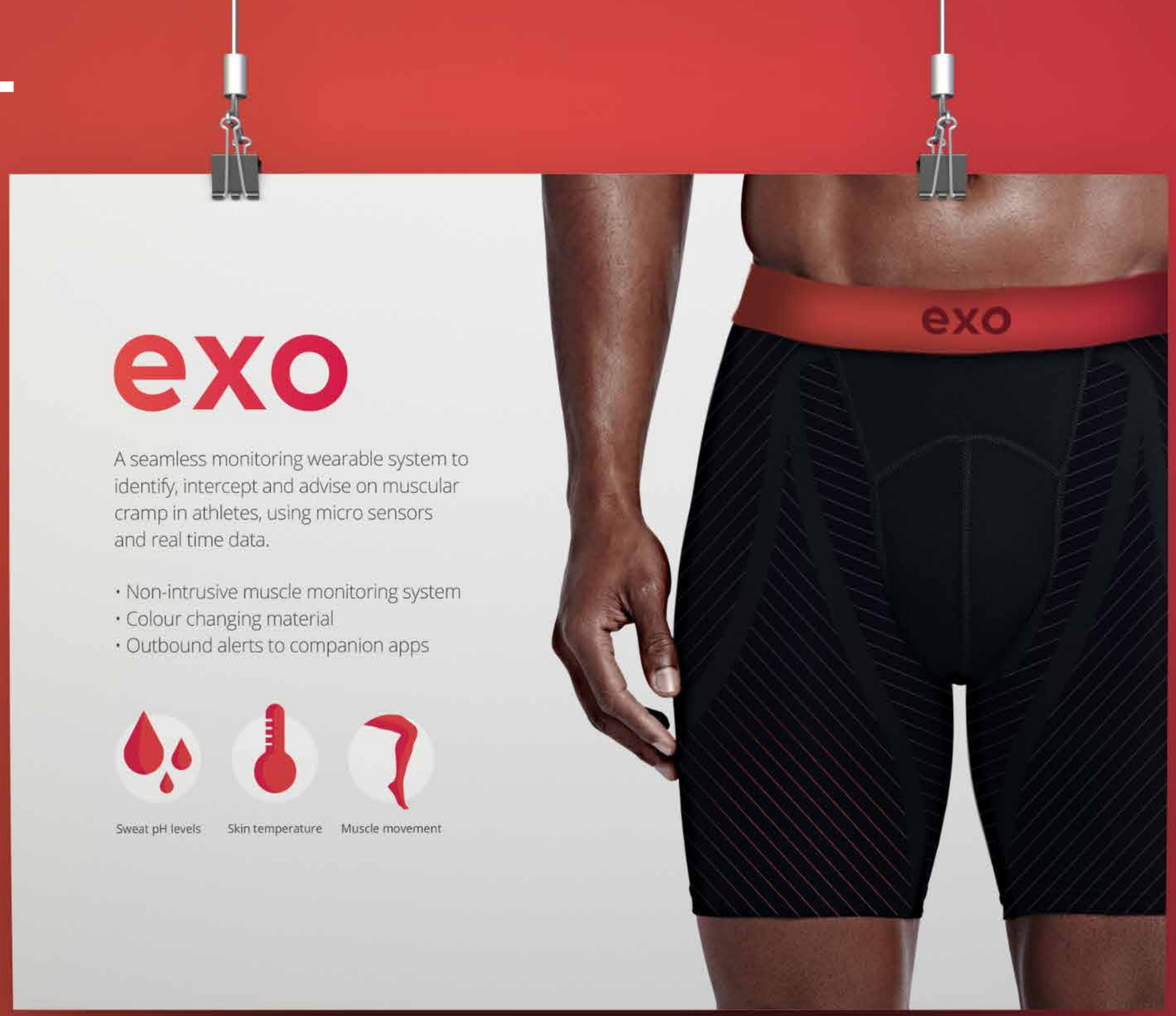
We pride ourselves on our non-invasive muscle monitoring solution, offering a seamless and almost invisible interaction between user and technology. The aesthetic of the shorts are the product of scientific and muscular research, alongside current market analysis and user feedback.

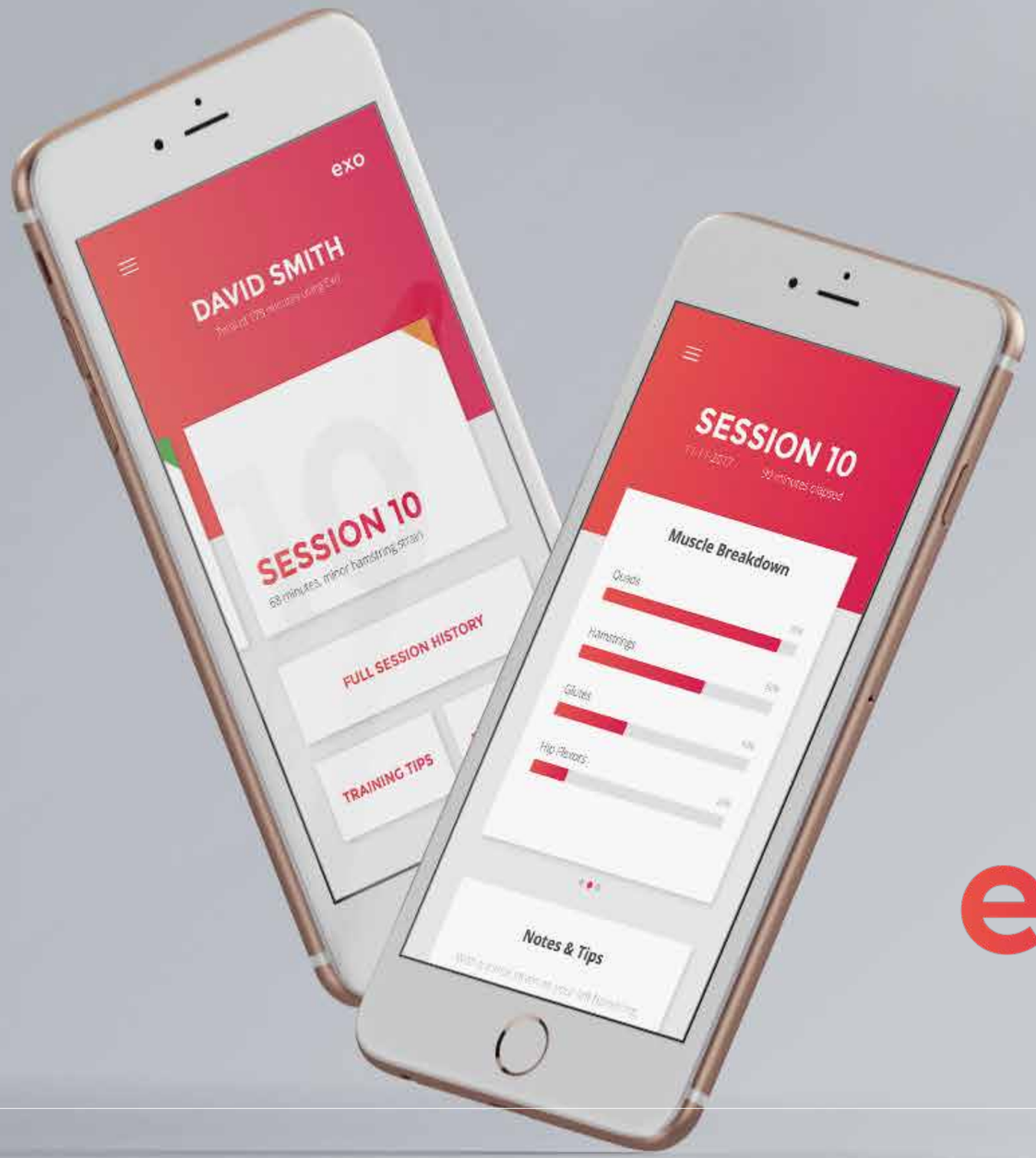
OUR PRODUCTS

The Exo package is focused around a pair of compression shorts that have smart elastomer and chemical ISFET sensors woven through them. These sensors can monitor the three main indications of muscular cramp. Sweat pH levels, skin temperature and involuntary muscle movement.

This data is collected and processed, causing the printed OLED fabric of the compression shorts to glow a red colour depending on the muscle condition. What's more, this data is collected in the companion mobile app, that provides a 'session summary' and builds a statistical analysis. Progress is displayed, and suggestions for future muscle care are given.

ADVERT


exo
A seamless monitoring wearable system to identify, intercept and advise on muscular cramp in athletes, using micro sensors and real time data.
• Non-intrusive muscle monitoring system
• Colour changing material
• Outbound alerts to companion apps
Sweat pH levels
Skin temperature
Muscle movement
exo


exo
DAVID SMITH
SESSION 10
FULL SESSION HISTORY
TRAINING TIPS
SESSION 10
Muscle Breakdown
Quads
Hamstrings
Glutes
Hip flexors
Notes & Tips

exo

exo pro

A tailormade professional service for professional athletes and sports leagues, providing real-time squad tracking coaches and medical staff.

Referee's can keep in the loop with detailed injury summaries direct to their smart watch, boosting player safety and fair play.

FUTURE PROJECTIONS

THE OLDER GENERATION

A target audience that would benefit from the technology of detecting and predicted cramp would be the elderly. A lot of elderly people struggle with cramp after they've been sat for a while. This can then have a knock on affect and cause serious injury.

By having the ability to detect the cramp before it occurs would allow any partners, family or carers to be notified of when they're suffering with cramp and can lend a helping hand.

We would have to think of a different method of outputting the data to be more in their face, as opposed to an app.

SPACE TRAVEL

A more far fetched thought for the use of Exo wearables would be in the Space travel sector. It would be a product that astronauts would wear to monitor their muscle activity in space.

By having the shorts, it would allow the astronaut to be in space for longer as they would be able to properly train their legs and measure their threshold for getting cramp or other muscle issues.

The shorts could also help when the astronauts return to space and their rehabilitation process. By allowing the astronaut to train properly in space, they can reduce their time in physiotherapy, therefore allowing them to return to space quicker and save their space program millions of pounds.

UPDATES & FEATURES

There are definitely a few updates and features to explore with our product. An online community to share and motivate progress with leaderboards and profiles would be something to explore within the companion app. This social element could boost user loyalty.

Additional features within the shorts seem to be desired by our audiences. We would definitely explore the technology needed to track distance, calories and other exercise related data. We could also try other patterns and colours to reflect different features and stats. This is because some feedback we received indicated that not everyone found the visual look of the shorts exciting. This could be down to the fact we wanted the function to be the most important, before the visual.