THE FUTURE OF THE RUNNING EXPERIENCE:
CAN WE POSITIVELY AUGMENT THE EXPERIENCE OF RUNNING THROUGH THE INTEGRATION OF INTERACTIVE TECHNOLOGY?

Master of Industrial Design
Project by
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Thank you to everyone helped me with my research during my industry visits, with specific shout outs to: Mark, Andrea, Ricardo, Wale, Graeme and Ash! Without you this project would never have begun.

A big thanks to everyone who helped me conduct my research. Thank you to the athletes, coaches, and friends who shared the happy and painful details of their lives as runners.
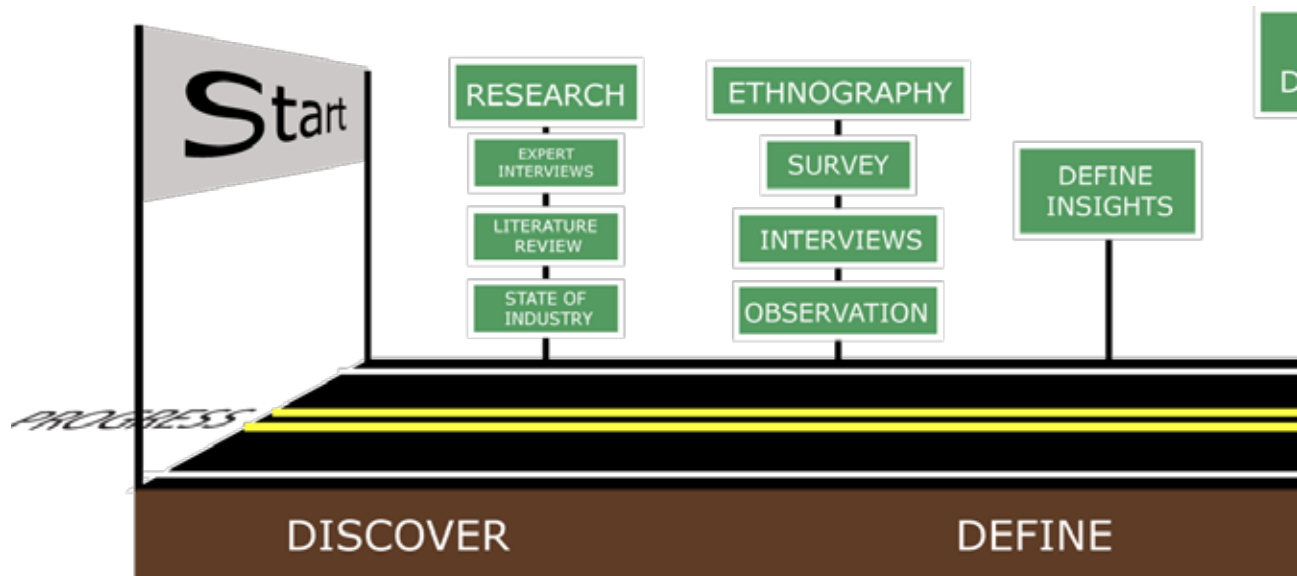
Finally, thank you to my team in academia, Kevin, Wei, and Luke, who had to manage my energy and guide me along in this process all while holding the keys to my future.
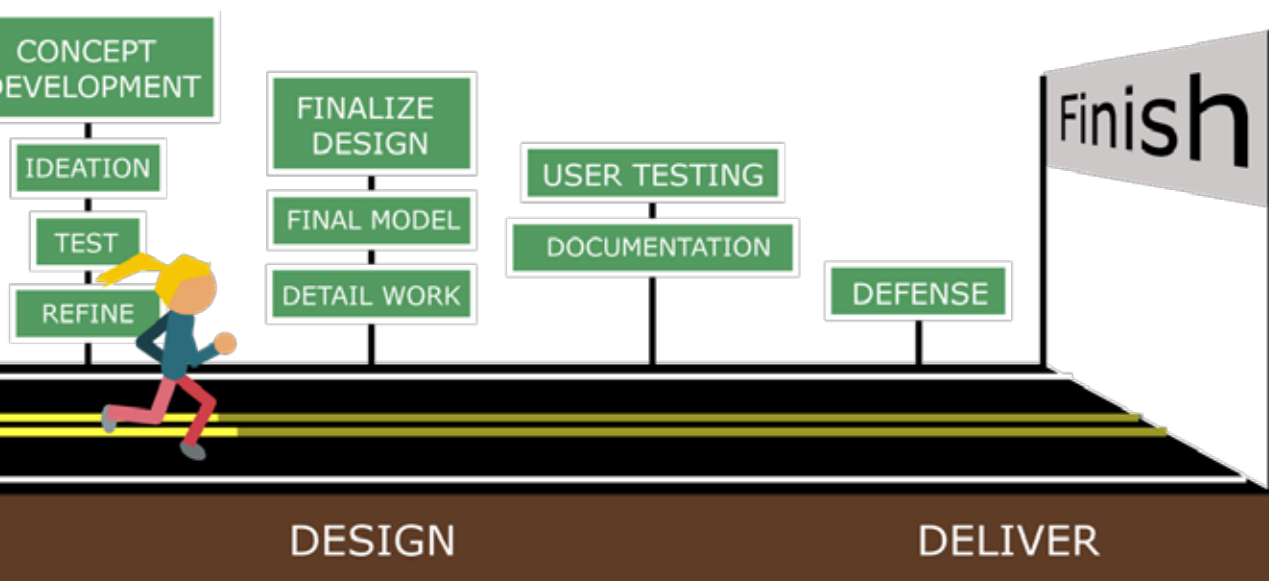
Abstract

The aim of this project is to answer the question: "Can we positively augment the experience of running through the integration of interactive technology?" This project utilized both user experience and industrial design methods to create a product that strategically leverages emerging technology to improve the lives of runners. To create this conceptual product I conducted ethnography to define pain points and key insights. Through those insights I was able to evaluate concepts through iterative user feedback and testing. My research indicated that runners do not know how or when they are hurting themselves during their runs. The final concept is a wearable sensor platform that utilizes machine learning to understand the runners' behaviors and how those behaviors impact their physical and mental health. The platform is then able warn users before they hurt themselves before, during and after runs. The final concept features the user experience of the total system and the industrial design of the final sensor.

Table of Contents

Design Exploration

This project can be broken down into two parts: ethnography and interaction design. Interaction design is a broad field of study and it is important to understand where in the discipline of interaction design my project falls. According to Daniel Fallman, the study of interaction design can be broken down into three main categories: the design practice, design studies, and design exploration. He defines the design practice as professional interaction design done in a consultancy, design studies as the research, and design exploration as design outside of the current paradigms (Fallman, 2008). This model can be seen in the image to the right. This project is between design practice and design exploration in a dimension that Fallman calls "True - Real - Possible" defined in the quote below:

"If design practice needs to be concerned with what is real and design studies with what is true, design exploration instead seeks to show what is possible; to show an alternative future; and to transcend current paradigms."
                                    -Daniel Fallman

Figure 3

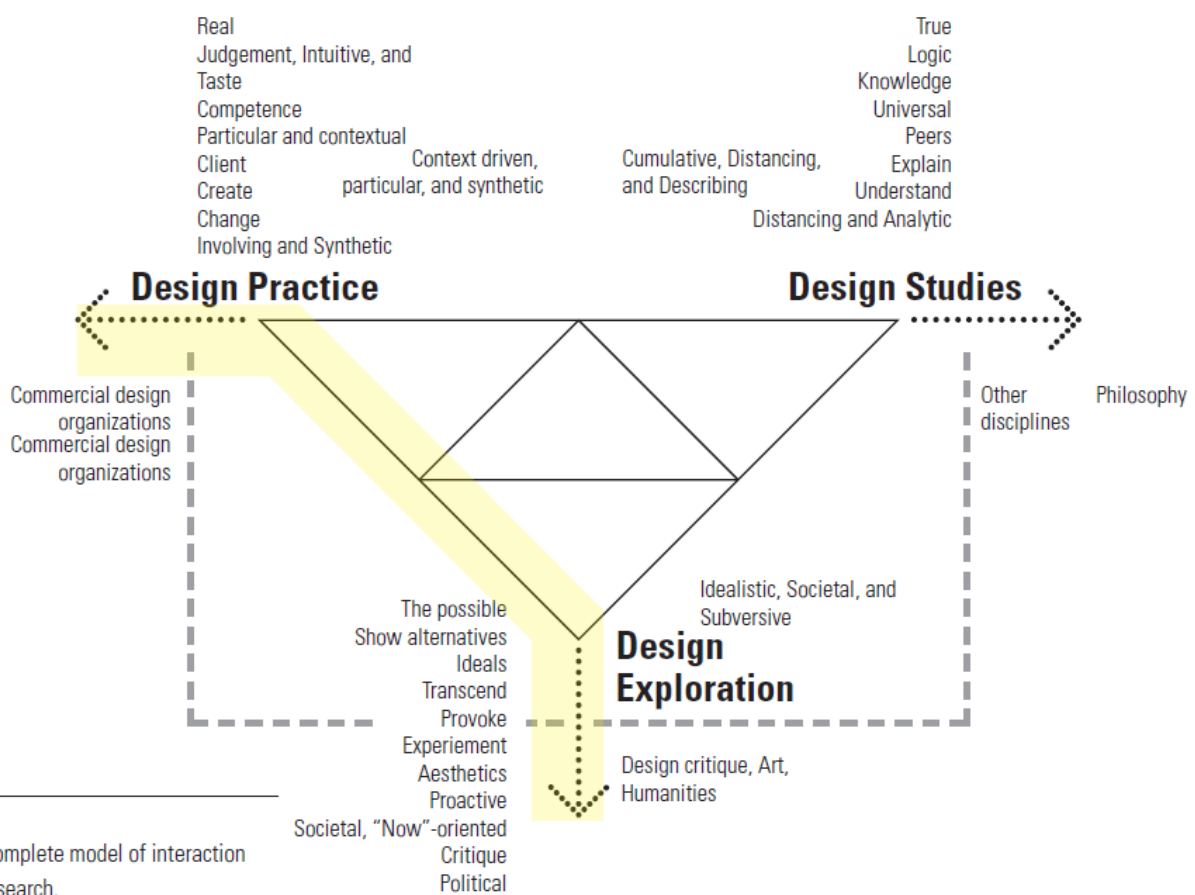A more complete model of interaction design research.

Diagram from The Interaction Design Research Triangle of Design Practice, Design Studies, and Design Exploration (Fallman, 2008).

Discover

Expert Interviews
Industry Trends
Technology Trends
Research Question

Expert Interviews

Trends, technology and everyday design in the athletic and outdoor industries.

It was critical to my project that I understood the landscape of the Athletic and Outdoor Industries before I formulated my research question. I traveled for three weeks around the United States conducting expert interviews with designers in five different companies: Adidas, Nike, Reebok, The North Face, and REI. I went to gain perspective on what it is like to work in these companies, to learn what these companies are actually doing, and to gain an in-depth understanding of the trends and technology in the Athletics and Outdoor Industries.

The Athletics and Outdoor Industries sell the same products to different target demographic groups. The two industries function in different ways with different long term strategies. The Outdoor companies and their design teams are more focused on the seasonal consumer, retail, and ethnography. The Athletics companies were focused on seasonal marketing and ethnography but they also have a heavy focus in technology and in-house manufacturing techniques.

The expert interviews I conducted have been redacted from this paper in order to uphold Non-Disclosure Agreements that I signed to preserve the privacy of the individuals as well as the corporations involved. The intent of this research was to understand overall trends which will be discussed in the next section.

Industry Expert Interview Guide

What trends do you see in the industry?

What emerging technology do you see influencing the future of sports and technology?

What problems do you run into?

What are big problems that your team is trying to solve (you don't have to answer this if it's proprietary info)?

The Author signed Non-Disclosure Agreements therefore the direct responses to these questions are not included in the text. The following trends are what resulted from the interviews.

Expert Interviews Results

Industry Definitions

The Athletics and Outdoor Industries sell the same products to different target demographic groups. The two industries function in different ways with different long term strategies. The Outdoor companies and their design teams are more focused on the seasonal consumer, retail, and ethnography. The Athletics companies were focused on seasonal marketing and ethnography but they also have a heavy focus in technology and in-house manufacturing techniques.

Marketing Strategy Defines Industry Classification for Companies

Outdoor Industry

Defined by selling and marketing products that get you out into the great outdoors.

Athletic Industry

Defined by selling and marketing performance athletic products.

Industry Trends

I am defining a trend as information I recorded independently from multiple sources. For example if I heard information from one source it would not be considered a trend, but if two independent sources relayed the same information I considered it a trend.

The Athletic Industry

Repatriation Of Manufacturing to USA: The Local for Local Trend

There is a push to bring manufacturing back to the USA through advanced manufacturing techniques. Adidas and Under Armour are both working on and advertising this fact publicly. The two main techniques that are being publicized are 3D printing of midsoles and 3D knitting for both custom and mass manufactured goods (Adidas, 2017; Under Armour, 2017).

Digital Creation and Prototyping

With Virtual and Augmented reality becoming more widely available, companies are re-imagining how they improve design through digital creation. Nike partnered with Intel to create a promotional video showing how the technology would be utilized (Nike, 2017).

"Sustainable" Shoe Solutions

Each Athletic company makes sustainability claims in different ways. Examples of sustainable solutions by some of the leading companies in the athletic industry are Reebok's Corn and Cotton shoes, Adidas Parley shoes and Nike Flyknits (Nike, 2017; Reebok, 2017; Adidas, 2017).

The Outdoor Industry

Inclusivity

There is a movement in the outdoor industry to design for more demographics. The Outdoor Industry wants to make outdoor gear more available to people of different body types, genders, backgrounds and ethnicities. Many designers acknowledged that most of the gear on the market today was designed for caucasian males and they are trying to move away from that. There has been a huge push in marketing toward women which can be seen in REI's current marketing campaigns as well as marketing videos by Outdoor Research, an outdoor gear retailer.

Resistance to Integrated Technologies

Multiple designers mentioned that there is a resistance to integrating technology into outdoor gear unless it is related to safety. This trend is particularly interesting to me becuase it is in direct conflict with this project.

Key Trends

The Athletic Industry	Common	The Outdoor Industry
Repatriation of Manufacturing: The Local For Local Trend	Lighter, Cheaper, Faster	Inclusivity
Digital Creation/ Prototyping	Dress Up / Dress Down	Resistance to Integrated Technologies
"Sustainable" Shoe Solutions	Design For Lifestyle	
	Shoe Specific	
	Cushioning & Response	
	Novel Enclosure Solutions	

This table outlines the Key Trends I discovered while researching the Athletic and Outdoor Industries.

Athletic & Outdoor Industries

Lighter, Cheaper, Faster

This is the mantra for all of the designers competing in the Athletic and Outdoor industry. All new innovative products must improve in at least one of these areas.

Dress up/Dress Down

The dress up and dress down trend is where an article of clothing could be appropriate for a more formal affair as well as a casual affair. Think a button down long sleeve collared shirt, great for the office and for the bar after work.

Design For Lifestyle

This trend came up in conversation several times. Designing for lifestyle means doing appropriate ethnography and understanding how your users live and creating gear for them. For example, different camping lifestyles include the intense overnight hiker, the day hiker, the causal camper and the glamper (glamorous camper).

Industry Trends

Wearable Technology

As technology has shrunk over time humans have been putting more and more technology on their bodies. Today wearable technology is commonplace, and can be found in a variety of garments including watches, jackets, and shoes. There are many companies that have introduced wearable technology specifially for shoes. Some examples include Nike's self-lacing shoe (Nike, 2017), Lechal's GPS guidance shoe insert (Lechal, 2017) and ShiftWear's shoe with dynamic screens (Shiftwear, 2017). The shoes and inserts made by these companies have pushed the technology of today to the limit and have shown that people are interested in embedding smart capabilities into their gear.

Shoe Specific

Cushioning and Response

Several companies I visited spoke about their novel midsole solutions. All of the big industry players are trying to find the balance between performance, comfort, and manufacturing costs. One designer spoke to the fact that the properties that designers look for to create performance midsoles can be found only in materials that are not considered sustainable.

Novel Enclosure Solutions

There has always been a push to create a new interesting way to get feet inside of shoes and to close them up comfortably and securely. Every shoe designer I spoke to mentioned the challenge and potential behind innovating on the shoe enclosure.

Technology Background Research

Literature review on emerging technology that relates to the fashion and athletic industries.

Emerging Technology

Wearables

Fashion and technology are rapidly colliding, specifically in the area of the fabric that we use to make our clothes. Yoel Fink, a professor of materials science at MIT, stated at the 2017 MIT Sports and Technology Symposium that there will be "Moore's law for fibers" and that we are in the beginning of "The Fabric Revolution" (Yoel, 2017). By suggesting that there is going to be a Moore's law for fibers he means that the computing power of fibers and thread is going to greatly increase year over year. Yoel's work includes creating a method to turn semiconductors, the building block of circuits, into fibers. His work demonstrates that in the future our garments could have circuits built into them through the fabric alone which means we could have incredibly lightweight computing power built directly into our garments. In the future we may have more advanced fabric sensors, and fabrics that can change color, biosense, see, hear, and respond to the environment (Orfa, 2011).

University of Cincinnati researchers have been creating sweat sensors to detect indicators in athlete performance. They believe that sweat will allow them to detect if an athlete is about to crash, if they will be susceptible to injury, and their level of exertion. It is worth noting here that the sweat sensors do not need to go through FDA approval because the are not meant to be used for diagnosis or treatment of disease. Therefore these sensors will be on the market as soon as they can make them commercially viable (Heikenfeld, 2014).

In 2016 professor Zhong Lin Wang of Georgia Institute of Technology developed a piece of woven fabric that can generate electricity from sun and movement. This technology demonstrates that in the near future we will be able to charge our clothing just by walking around and being in the sun (Brown, 2016).

Across the country, a collaboration between researchers at UC Berkeley and Google's Project Jaquard have developed Ebb, a color changing thread. The team created conductive thread coated with thermochromic paint that can be woven and crocheted into shapes, and its color can be manipulated into animations that move across the threads. The technology they created has a slow response to input, meaning that the input they give it takes time to respond and is extremely volatile. The color of the thread is related to the heat it experiences and can be easily changed by a cool gust of air (Devendorf, 2016).

Nonetheless, the research this team has completed is interesting because they looked at why people, both designers and non-designers alike, would want to wear color changing clothes. The researchers found that their participants did not like screens because the the light they emitted was "jarring." They also discovered that the participants preferred subtle feedback, meaning they preferred shapes and lines and did not want to see numbers and letters because numbers and letters are difficult to ignore (Devendorf, 2016). The Ebb technology's slow response time fed the participants' interest in playful and secretive interfaces that only reveal information to those who know where to look, giving the technology a sense of magical realism.

I would like to acknowledge that there has been a significant amount of research completed at Georgia Institute of Technology in the field of interactive garments lead by researcher Clint Zeagler. I am not including an in-depth description of that research in this document due to the fact that it mainly demonstrates application of emerging technology, not the technology itself (Zeagler, 2017).

Repatriation of Manufacturing

Advanced manufacturing techniques are allowing for the repatriation of manufacturing to the United States. The foundation behind bringing manufacturing to the USA means having more machines and fewer people making the products. Today, it takes 200 people to make a single shoe (Grossman, 2010), a fact that was repeated to me over and over again by shoe designers, which would not be financially viable in the USA. Therefore the equipment that companies are developing is aimed at decreasing the number of people working on the shoes. The two main types of equipment that are revolutionizing the way shoes and garments are made are 3D printers and knitting machines. By decreasing the number of human workers and by creating a more automated system it will be easier to create both local and custom goods in the future.

Expert Interviews Results

Demographic
Runners

My interviews allowed me to narrow down my choice of sports to running, basketball, and training at the gym. I chose runners based on their large numbers, availability, and passion for the sport.

Focus

Experience Design

True innovation impacts the end-to-end experience of running and I need to understand every nuance of a runner's journey.

THE RESEARCH QUESTION

Can we positively augment the experience of running through the integration of interactive technology?

Ethnography

Publications
Observation
Survey
Expert Interviews
Participant Interviews
Insights

Why Runners?

Large & Growing Numbers

There are a massive amount of runners in the United States and the numbers have been steadily growing year over year (Running USA, 2016). The large number of runners in the United States means that there is a viable market for diverse products.

Passionate

Have you spoken to a runner lately? If you do, you'll find that runners love talking about running. This project largely focuses on ethnography, meaning that I needed to speak to many participants, and finding participants who were willing to talk (for free) was critical.

Available Everywhere

Runners can be found almost anywhere you go! This gave my project the flexibility it needed as I am a frequent traveler and split my time between Atlanta and Rhode Island.

17,114,800

Number of Runners
that finished road races
in 2015

30,300

Number of running
events in 2015

All statistics on this page are from The Running USA 2016 State of the Sport report (Running USA, 2016).

The Culture of Runn

According to Periodicals

Extreme Comp

Nature

An

Trail Runn

Murals

Exploration

Adventure

Urban

Art

Competitio

Friends

Music

Spotify

Identity

Crews not Cl

Inclusion
Race, Gen
Speed, Ag

Expression

Tech

Nudity

Shoes

Culture of Objects

Costuming

Fashion

Per

Hero Worship

Histor
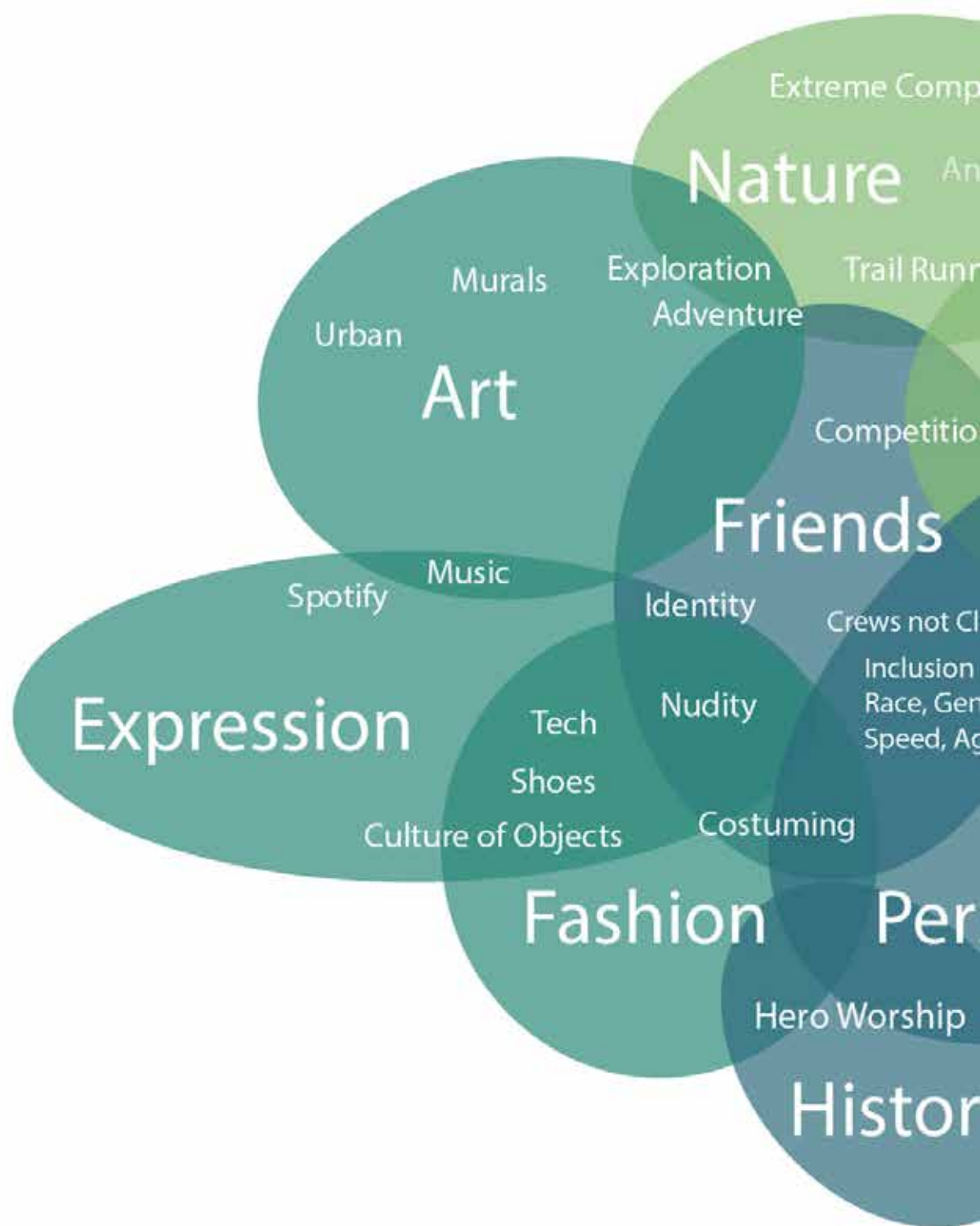
ing

I dissected the **printed** publications of the two top running magazines, Runner's World and Trail Runner, and mapped out the **common themes**.

etition

imals

Meatless

Fuel

Tacos

Food

ing

Alcohol

Weightloss

Body Image

Will Power

Disability

Training

n

Men's Body Image

Putting Pain in Perspective

Form

Age & Decline

Struggle

Rest

ubs

der

ge

Dogs

work

Recovery

Sickness

Chronic Pain

Family

Injury

sonal life

y

This map allowed me to understand what the media deemed as important and served as a cultural point of reference. I was interested in what the magazines decided to include and why, like men's body and not women's body image issues. The over-arching topics discovered through this exercise allowed me to formulate questions for my survey and speak with runners with greater fluency.

Observation

I struck out into the world to watch runners partake in different types of running related activities. I watched runners at events, group runs, outdoor solo runs, and running on the treadmill. I was able to map out the relative experiences of each type of run and gather an overall understanding of the unique pain points and benefits of each type of activity.
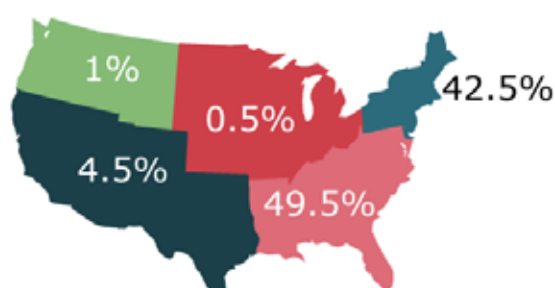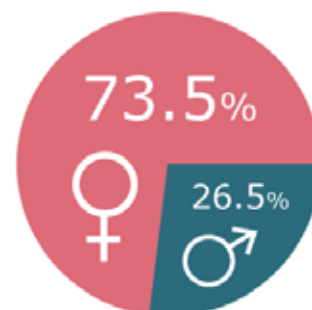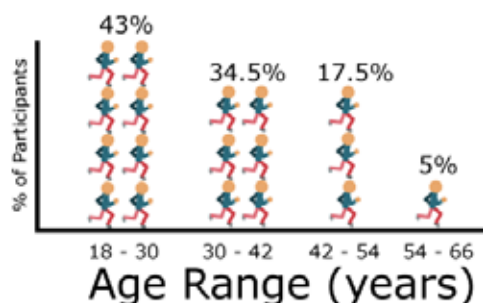
Learnings

- Boredom is an issue at running events
- Storage is an issue at all running venues
- Solo runs have the greatest potential for a runner to experience the runner's high

Race Day Journey Map
According to Interviews and Observation

The Experience of Typical **Good** Run
Based on Expert Interviews and Observation
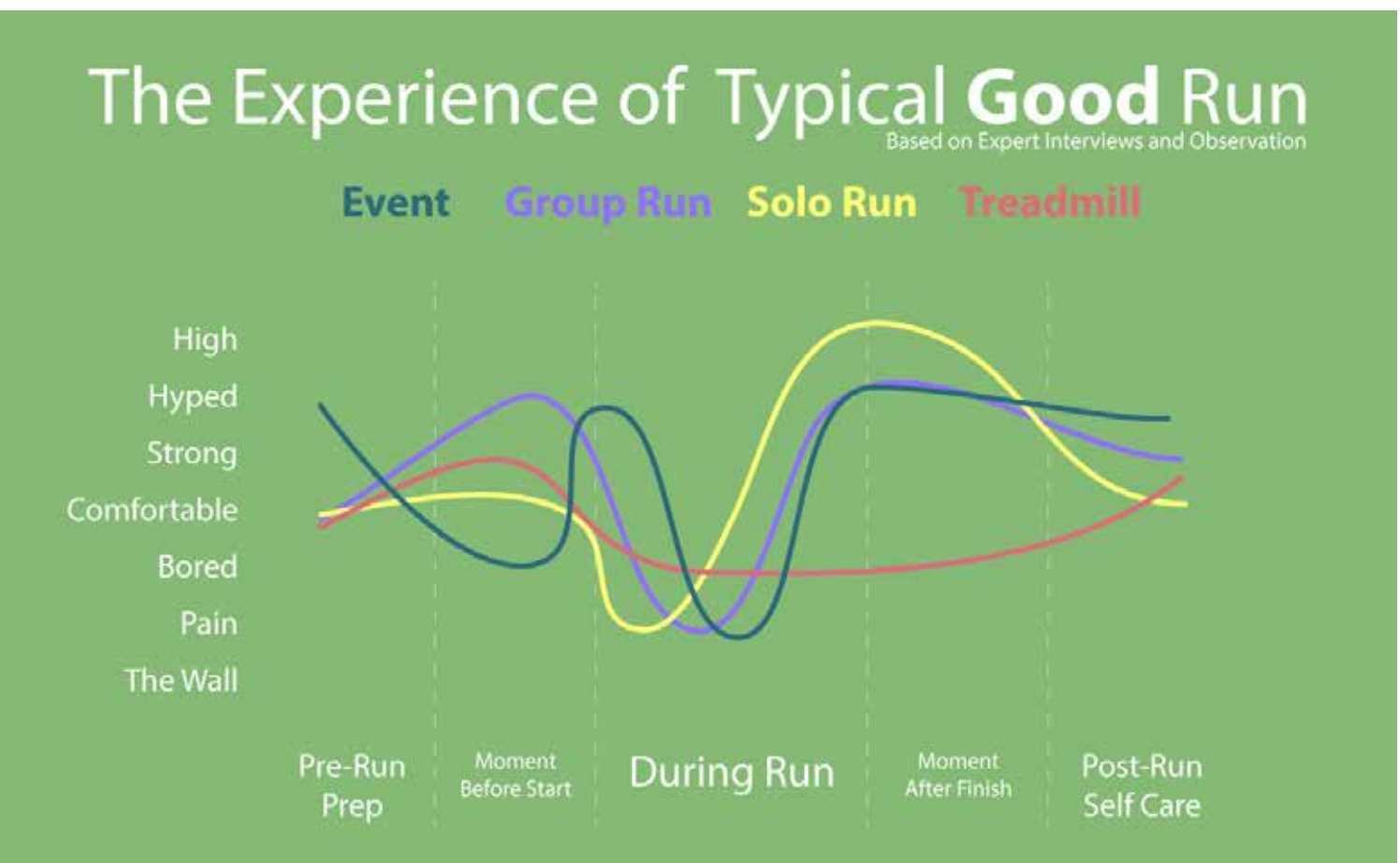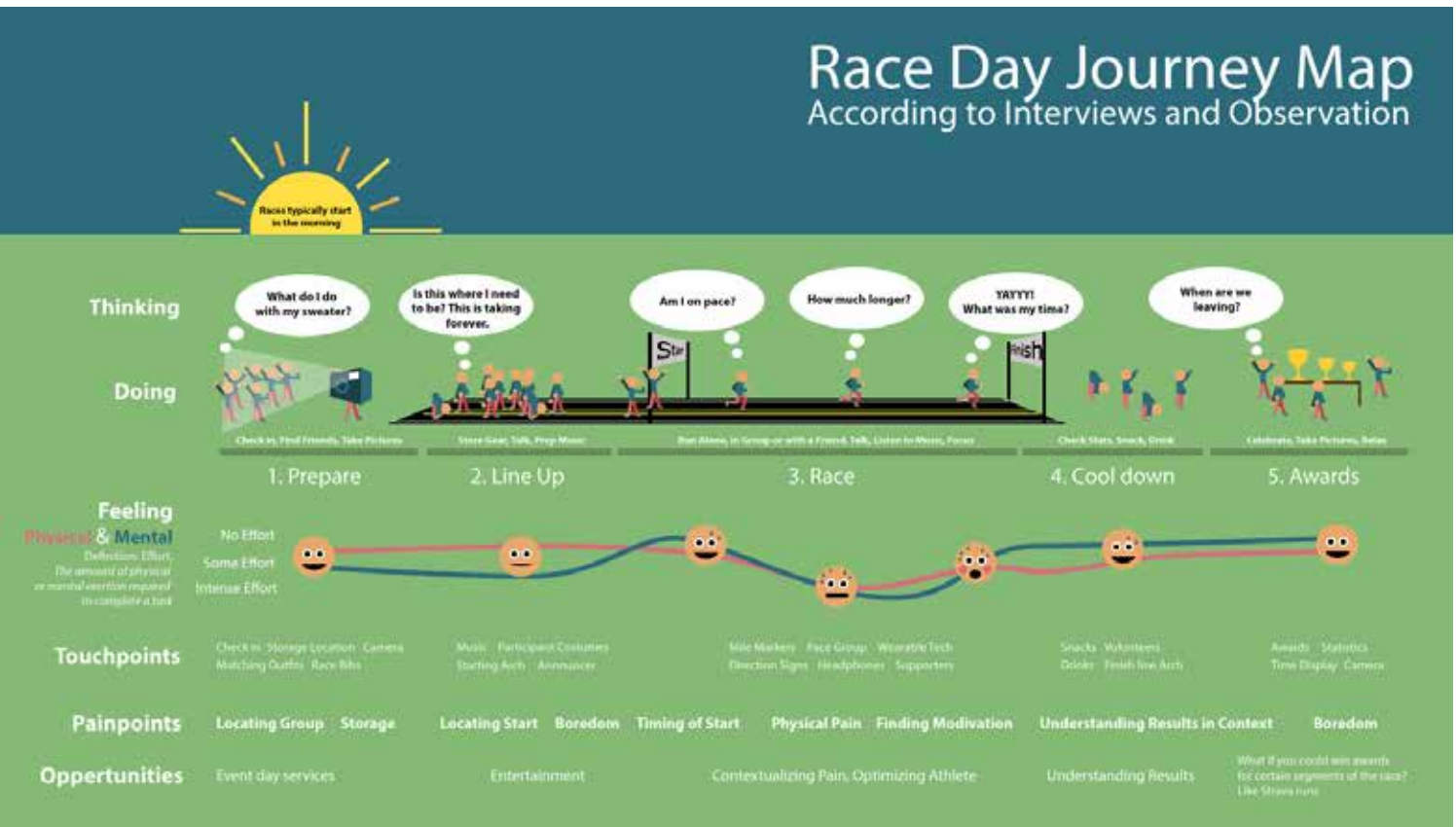
Survey Demographics

200 Runners

Age Range (years)

% of Participants

- 18 - 30: 43%
- 30 - 42: 34.5%
- 42 - 54: 17.5%
- 54 - 66: 5%

73.5% ♀

26.5% ♂

1%
0.5%
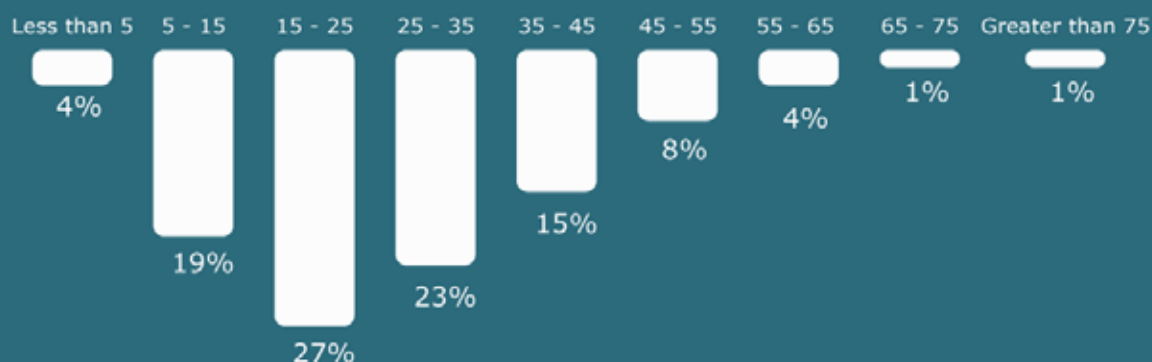4.5%
49.5%
42.5%

Cities 58%

Suburbs 40%

Rural Areas 6.5%

Survey

A survey was conducted with 200 participants that were recruited via social media. The goal of the survey was to generate knowledge so the researchers could understand what kind of questions to ask in the participant interview stage of this study. The survey contained 36 questions and could be broken down into quantitative and qualitative sections. The first half of the survey was quantitative, allowing the researchers to get an idea of what kind of runner was taking the survey. The second half of the survey was qualitative and asked open-ended questions regarding why the participants run and what keeps them motivated. These questions were purposely open-ended to generate as much new knowledge for the researchers as possible. See Appendix A.1 for the entire survey and Appendix A.2 for the social media recruiting post.

How many miles do you run in a week?

Less than 5	5 - 15	15 - 25	25 - 35	35 - 45	45 - 55	55 - 65	65 - 75	Greater than 75
4%	19%	27%	23%	15%	8%	4%	1%	1%

How long are your regular runs?

Miles	2	3	4	5	6	7	8	9	10
Percentage	3%	10%	19%	23%	22%	6%	8%	2%	3%
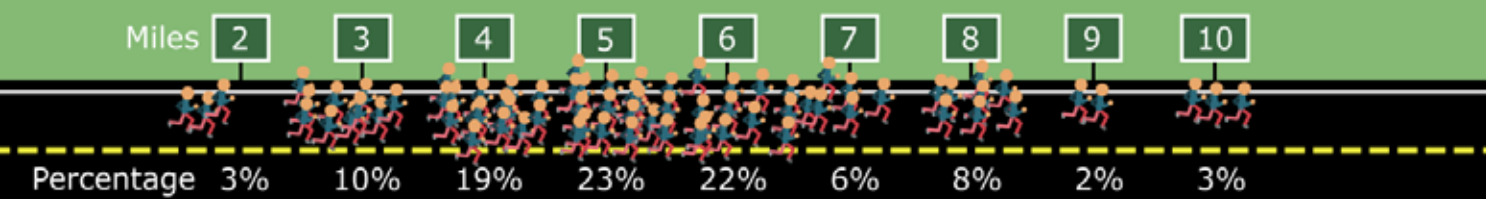
Is running your primary sport? **78% YES**

What time of day do you run?

AM: 32.5% / 1% / 49%

PM: 10.5% / 15.5% / 60%

78% Use Tech

Survey
Quantitative Analysis

All significant results from the survey were converted into the visual representations. Any result that could be quantified was represented in the percentage of respondents. The goal of the quantitative analysis was to understand the demographics of the respondents.

Learnings

- Today, there are more women running then men.
- Running is largly a sport conducted alone.
- Pace over distance is the best way to determine the relative perfromance of a runner.

Data Runners Collect

- Pace
- Time of day
- Distance
- Heartrate
- Elevation
- Calories
- Weight
- VO2

mapmy run

STRAVA

connect
powered by Garmin

NRC
NIKE+ RUN CLUB

Where do you get ready to go on a run?

Home	Work	Gym	Car	School
95%	30.5%	19.5%	11.5%	5.5%

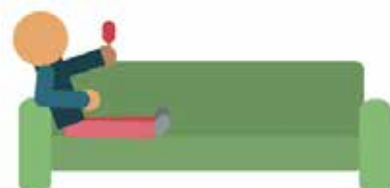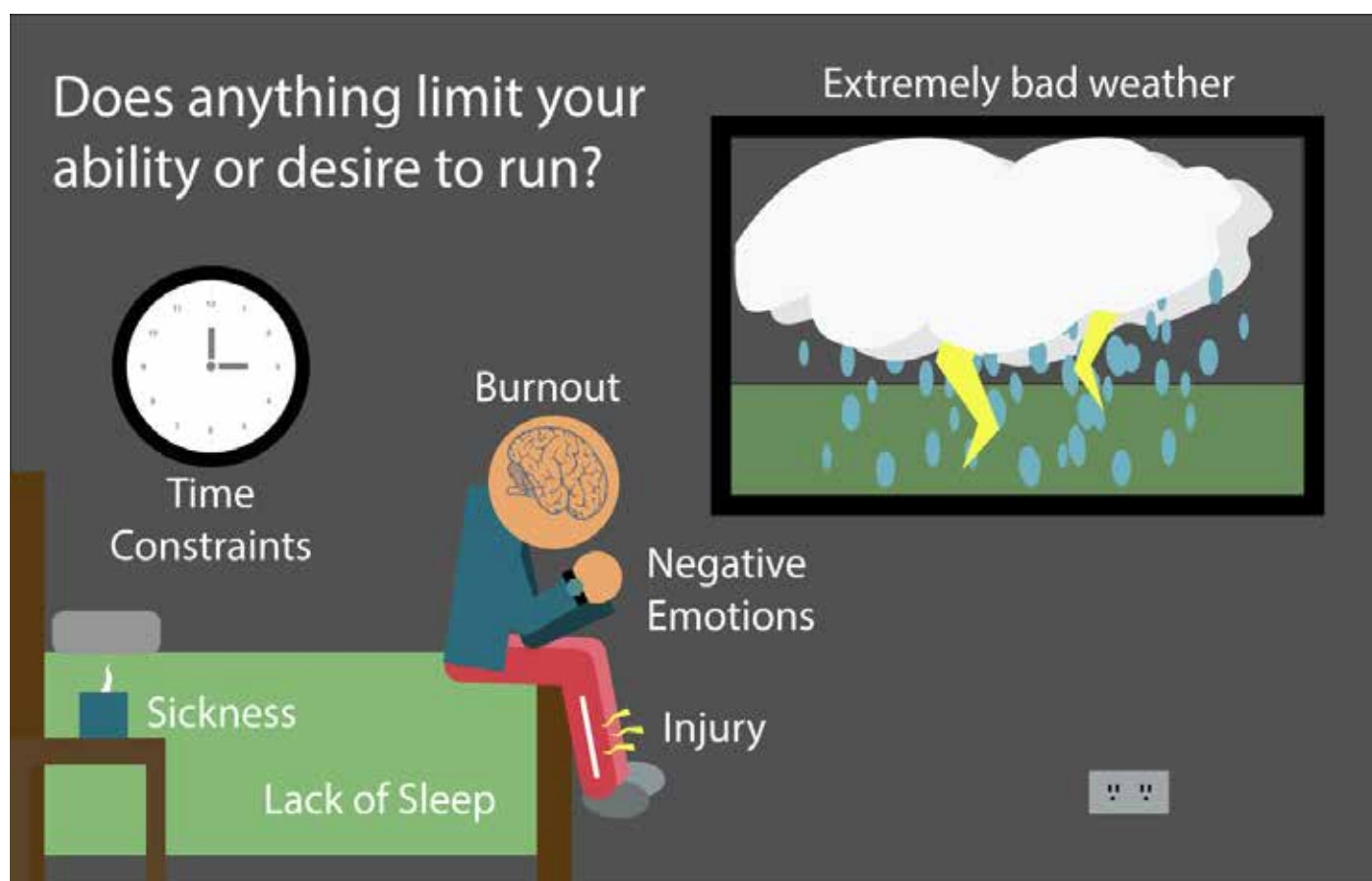## What do you do after you run?

Stretch   Hydrate   Shower   Relax & Eat

Survey
Qualitative Analysis

The majority of the survey included open-ended questions. In order to make sense of the results the researchers went through each response and coded the answer. For example, if the question was, "How did you start running?" and the response was, "I started running on my middle school soccer team," the researcher would code the response 'soccer' and 'middle school.' The researchers compiled all of the coded resposes   to look for major themes. These themes informed the next round of questions for the participant interviews.

Learnings

- Family and Friends are critical to the success of beginners.
- Running positively improves the mental health of runners.
- Runners are very picky about the gear they wear.
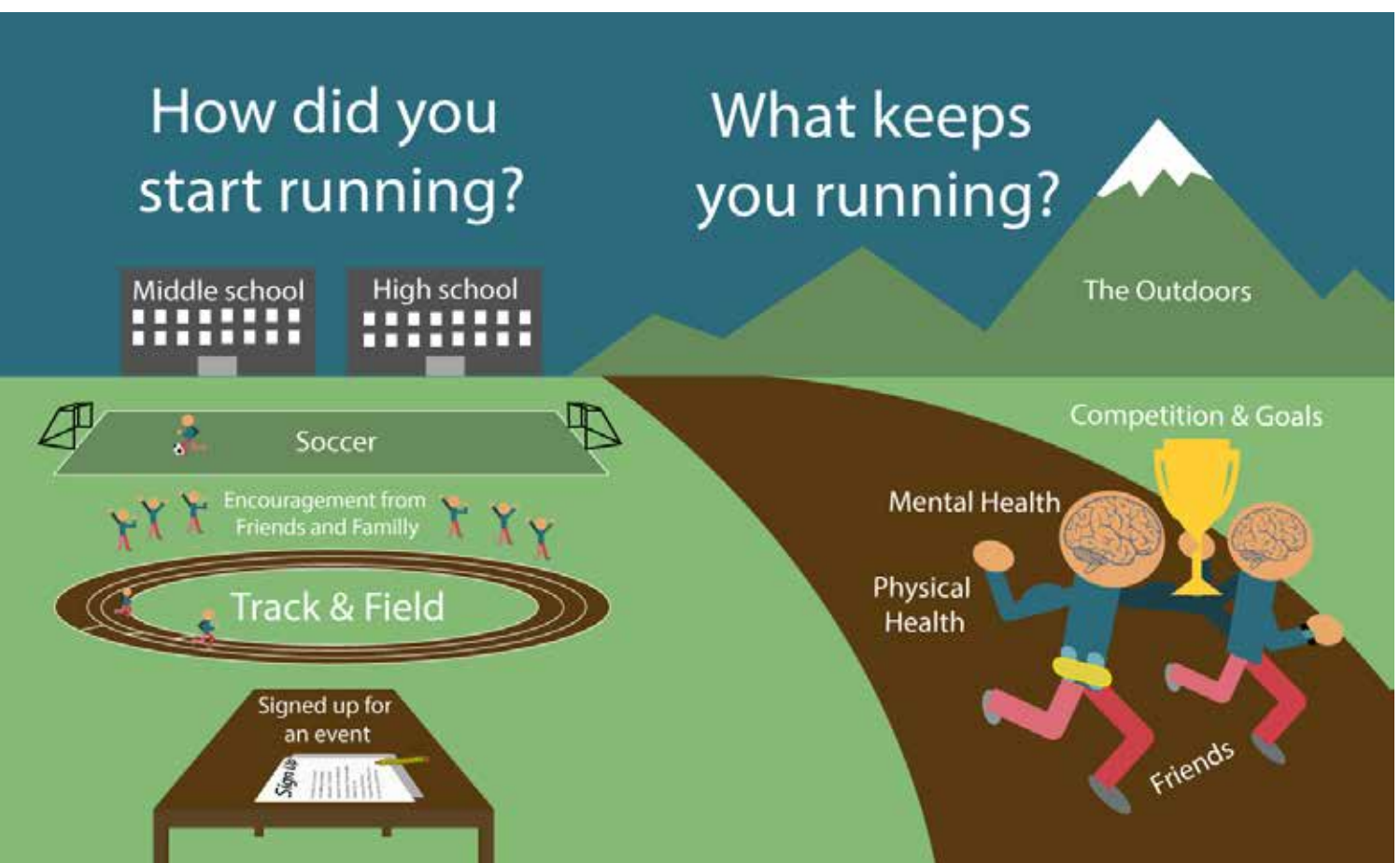
Survey Lessons Learned

Pace over distance, not distance alone, is an indicator of how high performing a runner is.

There is a culture of adventure and exploration within the running community.

Extreme weather can influence when a runner runs during the day and if they do it indoors or outdoors.

The treadmill is polarizing – runners love it or hate it.

Personal beauty routines can influence when a runner goes on a run.
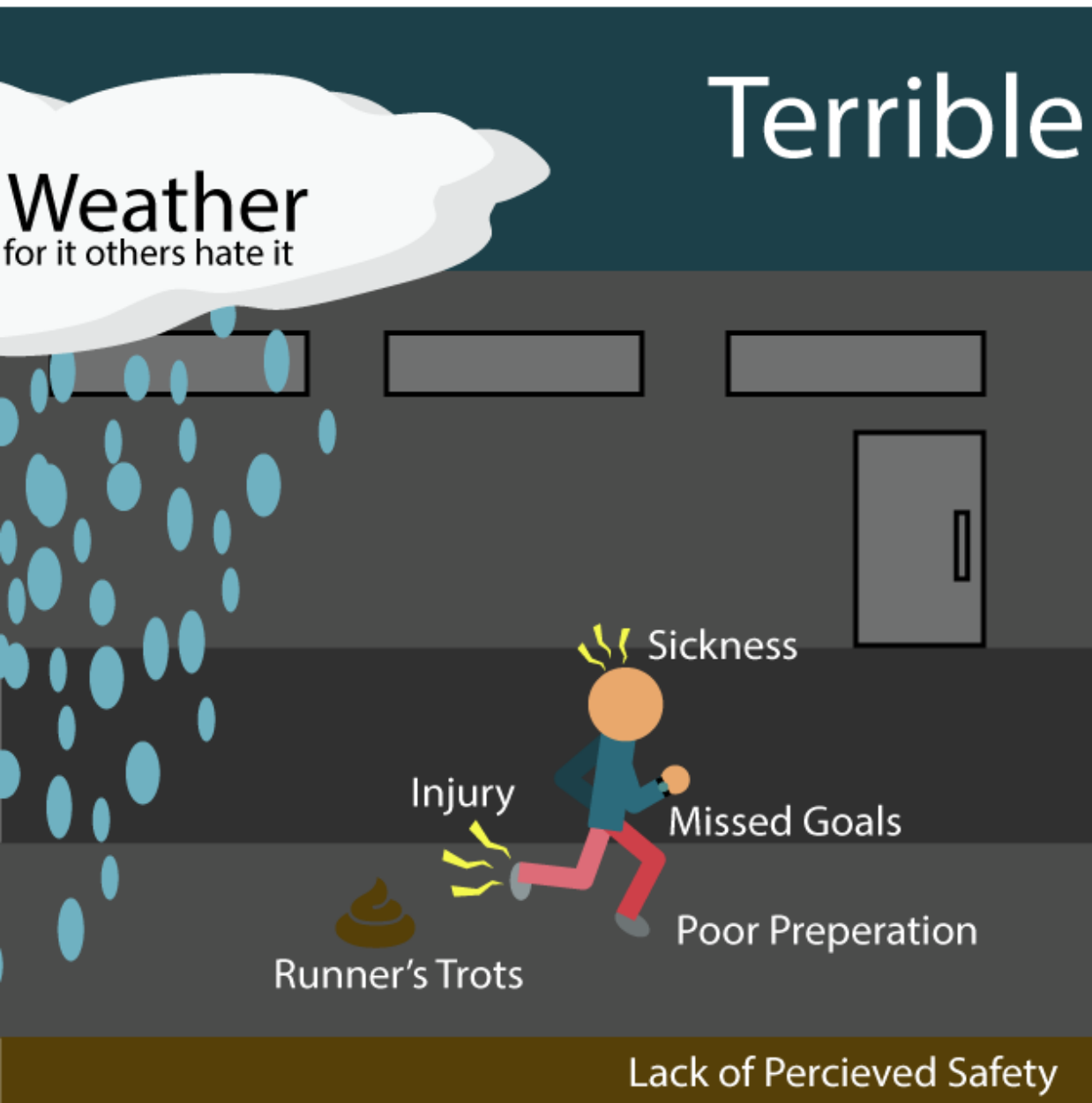
People enjoy how their mind empties on a run and new technology should not disturb that feeling.

Runners are relentlessly positive people -- even when asked to describe a bad run many responded to the tune of "every run is a good run!"

The runner's high is a misnomer; it should more appropriately be called the runner's zen.

Expert Interviews

I conducted hour-long interviews with five highly recommended coaches in the Atlanta area. The key takeaway from these conversations was the categorization of types of runners. There are three types of runners who have vastly different needs and goals: the beginner, the goal driven, and the elite. These interviews allowed me to understand that my target demographic for this project are goal driven runners.

Learnings

- Feel is more important than quantifiable metrics when it comes to training.
- There are three types of runners, beginners, goal driven and elite
    - Each group is defined by their goals are and performance

Major Catagories of Runners
According to coaches

To date four expert interviews were conducted with running coaches,These graphics will update as I continue to interview more coaches

Beginner
Just starting

Goal Driven
Seasoned Runner

Elite
Top 5% of age class

Goals

Beginner	Goal Driven	Elite
Lose wieght	Reach fullest potential	Reach fullest potential
Get Healthy	Improve performance	Win Competitions
Finish 5k	Train Efficiently	Qualify for competitions
	Finish Race	

Training Key Info

Insights from Interviews with running coaches

1 Runners must change up execises to improve

2 Every runner is different, workouts are based off of their relative abilites

3 Feel matters more than metrics, runners must develop a keen sense of feel

Talking and running is fun

Talking and running is fun

Talking and running is difficult

I can not talk, focus on pushing my pace

I can not talk, my legs are on fire!

	Easy	Long Run	Marathon Pace	Tempo	Interval
Intensity					
Length					
HR Zone	2	2	3	3	4 or 5

Expert Interviews
Key Takeaway

Target Demographic:
The Goal Driven Seasoned Runner

I chose this demographic because it includes the most runners possible while still targeting a group with similar needs. Goal driven runners have incorporated running into their lifestyle and want to continue to run for as long as they can. Goal driven runners are all ages, genders and races what makes them similar is their drive to improve their performance year over year.

Goal Driven
Seasoned Runner

Reach fullest potential

Improve performance

Train Efficiently

Finish Race

Participant Interviews

10

Number of
Interviews

I conducted ten hour long interviews with participants from my survey. The interviews allowed the research team to define final insights and design criteria.

Participant Interviews

Ten participant interviews were conducted either in person or via a video chatting platform. These interviews allowed me to map out general themes and target specific pain points. Runners expressed that the worst thing that can happen to them is being unable to start or finish a run. Based on this feedback each pain point was evaluated on a scale from one (does not stop you from running) to five (you cannot run if this pain point arises).

The interview script can be found in Appendix B.1.

The Goal

Define the most critical problem spaces and the severity of those problems

Interview Excerpt

Semi-structured Interview Outline
The Experience of Running
Time: 1 hour long

Introductions

What is your age?
How long have you been running?
Do you consider yourself a runner? When did you start considering yourself as a runner?
What type of runner are you? [Probe: Elite, Beginner, Casual, Semi - Causal]
How long are your normal runs?
What type of terrain do you normally run on? [Probe: When its hot, when its cold]

The Experience

Please Describe your typical run from beginning to end.

What do you do before you run?
What do you do while you are running?
What do you do after you run?

How do you recover from run? [This is specifically meant for tempo or more difficult runs]
How long does recovery last for you?

How do you feel over the course of a normal run?
[Use paper here have them draw a graph of how they feel before during after a run]

When do you decide you are going to go on a run?
Does running affect any of your habits? [Probe for eating, sleeping, self care, social habits]
How long do you feel the effect of running?
How often do you think about running?

Pain Points
What is the most annoying part of running? [Probe for: preparation, running, pain, self care post run]
Do you find anything frustrating about running? [Probe for: slowing down with age, injury, runner's high, hitting the wall, poop]
Have you ever hit the wall? Tell me about it.
Do you have issues storing personal effects?

General Probes: Injury, poop, extreme weather, poor preparation, missed goals, emotional distress, sickness

Results
Participant Interviews

Themes

Race

Today, in the United States, the sport of running is dominated by Caucasian women. In the past, it was dominated by Caucasian men. Black and Latino populations are much less likely to be runners, which is an area that could be further explored in another study (Jennings, 2015).

Life

Running is a personal lifestyle that mainly occurs alone and impacts the runner's emotional and physical state of being.

Technology

Depending on the run, runners find technology more distracting than helpful.

Community

Community is only critical to the success of beginner runners.

Runners at a 5K

Results
Participant Interviews

Problems & Insights

The page on the right side of this spread shows the problems discovered and the insight that supports it. The graphic below explains the layout.
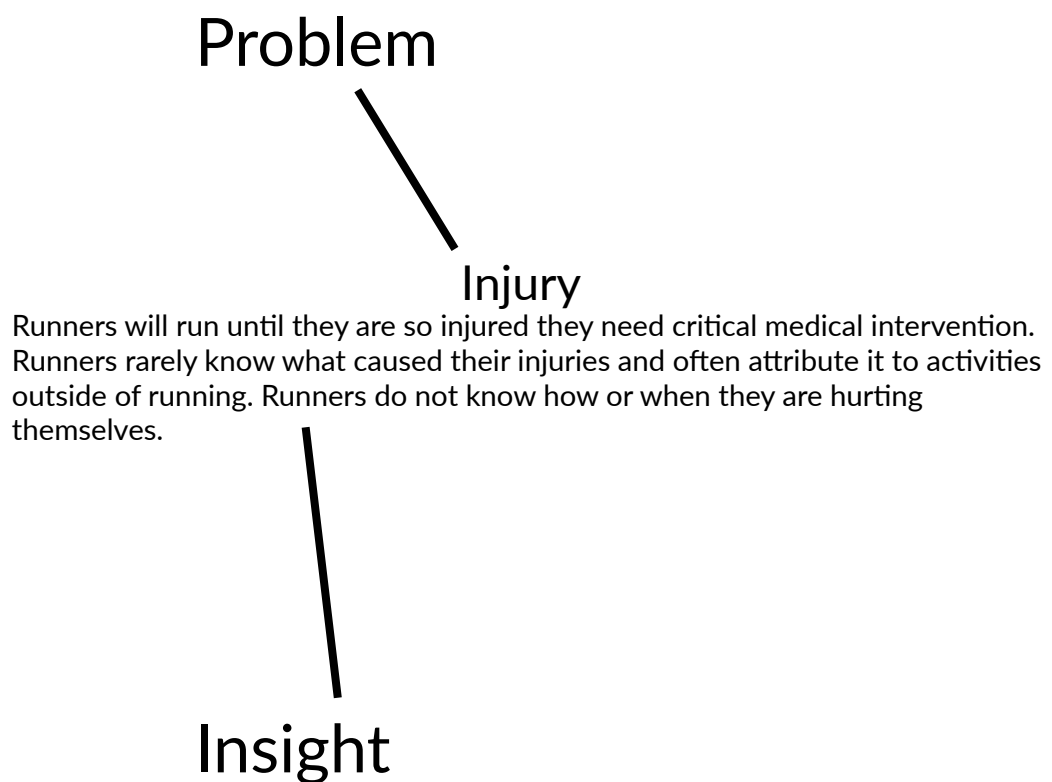
Problem

Injury

Runners will run until they are so injured they need critical medical intervention. Runners rarely know what caused their injuries and often attribute it to activities outside of running. Runners do not know how or when they are hurting themselves.

Insight

Injury

Runners will run until they are so injured they need critical medical intervention. Runners rarely know what caused their injuries and often attribute it to activities outside of running. In short, runners do not know how or when they are hurting themselves.

Starting Over Again

Coming back from a break or injury rehabilitation is extremely difficult physically and emotionally.

Boredom

Running events like 5ks and marathons can be extremely boring. The treadmill experience can also be extremely boring. Runners want interesting scenery regardless of if it is natural or part of the built environment.

Adjusting your Goals Mid-Race

Changing a goal mid-race is extremely difficult emotionally.

Adjusting your goals due to life changes

Putting your current physical status (injury, pregnancy, age) into perspective is difficult.

Body Temperature

Temperature makes or breaks the running experience and dictates the runners' behaviour.

Storage

Runners want to carry equipment that have all of the features (distance, time, photography, calling a cab, making calls, directions) of a cell phone without the storage issues of a cell phone.

Safety

Runners change their behaviour depending on their perceived level of safety. Cars are perceived as more dangerous than violent humans. Verbal harassment is the most common type of unwanted attention that occurs.

Time

Running takes time and runners run around their busy schedule.

Extreme Weather

Extreme weather, both hot and cold, is polarizing. Some love it, most hate it. It drives people onto the treadmill, which is another polarizing option.

Results
Participant Interviews

Through conducting participant interviews it was found that the worst thing that can happen to a runner is being unable to start or finish a run. The research indicates this is because someone who is a runner only feels like themselves if they are able to run. This feeling like oneself is can understood as self actualization. Self actualization is the top of Maslow's hierarchy of needs meaning that is allows runners to be realize themselves, their purpose and their happiness. If runners can not run they do not self actualize.

Severity
Defining the intensity of the problem

1	Does not affect run
2	Run less enjoyable
3	Interrupts run
4	Cannot finish run
5	Cannot start run

Pain Points

Which problems are worth solving?

To determine which problem should be solved I created the ranking system you see below. The more intense the problem, the more valuable the solution will be to the final user.

Problem	Severity
Injury	5
Starting over again due to injury	2
Boredom	2
Adjusting your goals due to life changes	1
Adjusting your goals mid race	2
Body Temperature	2
Safety	4
Time	3
Extreme Weather	2

Summary

Expert Interviews, Observation, Survey, Participant Interviews

Target Demographic

Goal driven Runners, see description on page 44.

Gear Design Criteria

- People enjoy how their mind empties on a run and new technology should not disturb that feeling.
- Lightweight
- Good Storage
- Chaffing Protection
- Must gather relevant data
- Must allow for expression of personal style

Cultural Insights

- There is a culture of adventure and exploration within the running community.
- Extreme weather can influence when a runner runs during the day and if they do it indoors or outdoors.
- The treadmill is polarizing yet required device during the months of extreme weather
- Personal beauty routines can influence when a runner goes on a run, especially if the runner has their hair treated.

GEAR MONITORS SWEAT · · DETECT IM

· TELL MEW
INE REA

BUDDY · STORAGE PODS DROPPED

DRONE · KEY REDESIGN/STORAGE OPTION -

NG · MEN'S STORAGE SOLUTION

AS · SERVICE PLATFORM · WATER BOT

DOGS STORAGE CO

AR RUNNING

RUNNING -AR GLASSES -LIKE PIKE MIN GO· · RE

OUR with sound scapes & smells · HY

YOU TO PEERS PLATORM] MOBILE PLATFORM

PATH ·

RUNNING · SOFTWARE UNDERSTANDS PREVIOUS

at deps gifts as you run · sexy body reminders

BLASTER · TAKE PHOTO FLASH OF HARRASSER. · RUNNING SK

ALLSTOP CONNECTED TO BILLBOARD · ALERTHAIR

RUNNG BUDDY-VOICE/EYE ACTIVATED · REFLECTIV

· LONGER LASTING SHOES · BUDDY SYSTEM · FORCE

ES · RUNNING HACKATHON -EVENT · STARTER PA

NITIES · GROUPS · EDUCATIONAL CH

HICLE TREADMILL · COMMUNICATING HOW LONG YOUR

MOTIVATION PROGRAM · AGGREGATE RUNNING OR

NT TRAINGING · PERSONACIZED PLAN · TR

—WITH RUNNING BUDDY

BLE · RATE DETERMINE TO BUY TEM

ATED CLOTHES · BODY MONITOR -PREVENT EXTREM

ING FABRIC · SMART LAYERS STRIP OFE

ING/AR RUNNING · GAME PLAN, INDOOR W/OU

BBLE · TREADMILL ROOMBA, M

ONE TREADMILL · ABUSE PLATFORM

Concepts

Concepts
Key Insight
Refined Direction
User Study
Totem

Concepts

I ran brainstorming sessions to come up with as many solutions as possible that could address the problems I discovered. I used a morphological matrix to map out what the problems were, what the current solutions were, the severity level of those problems, and concepts that could address those problems. At the end of this ideation session I had over seventy concepts to consider and narrow down. Five concepts were selected based on how well they addressed a problem, and the potential to embed emerging technology into the solution.

CONCEPTS

• ML PLATFORM
• WEARABLES MONITOR SWEAT • STICK ON
• BODY IMPLANTS
• RUNNING GEAR MONITORS SWEAT •

• FULL BODY SUIT /
• POSTURE MONITOR

•DETECT MUSCLE S
• TELL ME WHERE
INE KEACE

• RUNNING BUDDY
            DRONE
• PET TRAING
• BREED DOGS AS
    RUNNING DOGS

• STORAGE PODS DROPPED
• KEY REDESIGN/STORAGE OPTION - SOUND
• MEN'S STORAGE SOLUTION   RATTL
• SERVICE PLATFORM

• WATER BOTTLE /
  STORAGE COMPARTM

TRED - VR/AR RUNNING
GAMAFIED RUNNING - AR GLASSES - LIKE PIKE MN GO • PROGRESS
TRED IN POD VR with soundscapes & smells   •HYPE CREA

• COMPARING YOU TO PEERS PLATORM] MOBILE PLATFORM
•SHOWING YN PATH •
•GHOST/AR RUNNING   • SOFTWARE UNDERSTANDS PREVIOUS PATTER
•Seruze that drops gifts as you run   •sexy body reminders •AbusI
•LOUD NOISE BLASTER •TAKE PHOTO of HARRASSER •RUNNING SKY BRID
•WEARABLE CALLS COP   CONNECTED TO BILLBOARD   •ALERT AIRTIG
•WEAPONIZE RUNNUG BUDDY-WICE/EYE ACTIVATED •REFLECTIVE CLOTHE
PRCAMPAIGN,   •LONGER LASTING SHOES •BUPPY SYSTEM •FORCED MEES
CHEAPER SHOES   •RUNNING HACKATHON -EVENT   •STARTER PACKS
SAFER COMMUNITIES •GROUPS   •EDUCATIONAL CHILD THIN
•AUTONOMOUS VEHICLE TREADMILL •COMMUNICATING HOW LONG YOU REALLY NE
•WORK/RUN MODIVATION PROGRAM •AGGREGATE RUNNING DATA CREA
•MORE EFFICENT TRAINGING   •PERSONALIZED PLAU •TREADM
•RUNGHUNTING -WITH RUNNING BUDDY)

RUN IN BUBBLE
VR RUNNING   • RATE DETERMINE (O BY) TEMP DATA
COOLING/HEATED CLOTHES •BODY MONITOR -PREVENT EXTREMES FEEL
• SMART MORPHING FABRIC   •SMART LAYERS STRIP OFF AS YOU

VR RUNNING/AR RUNNING   • GAME PLAN, INDOR W/OUT TREAD
FUNING BUBBLE   • TREADMILL ROOMBA, MOVE FROM
LOW COST HOME TREADMILL •ABUSE PLATFORM

Concepts

The table below shows all of the concepts that were considered in this project.

Problems	Injury	Re-injury	Storage	Boredom - Outside	Boredom - Treadmill	Starting over again - injury, time	starting over again - setting goals mid run	Ch ex yo pr
	Machine Learning Platform Identifies trends in all parts of your life (exersize, eating, sports, walking, work)	What should I eat App to hit weight goals	Running Buddy (rolling or drone)	AR Glasses gameafied running	VR Running glasses	Showing you the path to recovery platform	Smart software understands patterns creates new goals as you need them	co pe
	Wearable monitors sweat at location of injury		Pet Training program to be your running buddy	Progress visualization wearable	AR Running glasses	Service that drops gifts as you run		gh
	Body impants monitor body state		Create special breed of running dogs/aminal/bird/cat	Tamagachi Running buddy, it grows as you run	VR multi sensory running pod, temp, smells, air flows over you	sexy body reminder software Softwear that says abusive things to you when you do not run		
	Everyday clothes monitors your daily postures		Service- Storage pods dropped along route	Headphones that don't suck	make treadmill floor feel like real ground			
Concepts	muscle spasm detecting tight body suit		Key Redesign so they don't move or rattle	Group Running gaming app	App that creates HYPE	Group accountability Subscription to personal accountability coach		
	tell me where it hurts educational mobile platform		Men specific storage solution					
			bras designed specifically as storage Service where people carry your stuff for you while you run water bottle/storage compartment Wagon pulling dog service swaddle body pocket that moves with you exactly, no key movement					

Changing expections as you age, pregnany, life	Safety - Cars	Safety - Violent	Harrasment	Racial Divide	Time	Temperature	Extreme Weather
comparing you to others platform	wearable communicates with autonomous vehicles to drive around you	Weaponized Running buddy- voice eye activated	Loud noise blaster/light flasher/camera	PR campaign	Autonomous Vehibile VR running	Run in bubble	VR/AR running on treadmill
cost AR/VR running	clothing that responds to enviornment-contrasts	pepper spray drone	takes photos of harraser and puts it on a billboard	Cheaper more durable shoes	Running program through workplace that requires regular running, run for bonus	Cooling & Heated clothes	Outdoor running bubble
		wearable calls cop	Skybridge across city only for runners membership to service/club that brings you to safe running areas	safter communiites	Peronalized effiecent training mobile app platform	Route dependent on localized temp data	Low cost home tredmill
		Hair tie acts as alert for cops		running hackatho n event	Run Commuting -cities collect data and create paths	Body monitor warns you before you become uncomfortable	App that gives you alternative workout gameplan
					App that communicates how far you need to run with all of your other daily activities in mind	App that makes you get the runners high easier	Outdoor backyard treadmill in clear bubble, you watch the weather and run
		Panic Button wearable		buddy system- event			
				Forced diversity buddy event, no diversity no event		smart layers that strip off or retract as your run	
		wearable tazer			Treadmills on public trasportatioin in house-Running Rooba, Run and cook run and clean runa nd work	smart fabric that opens up as you heat up	
		AntiMugging gear		Running starter pack			
				Childhood education reachout program	Running club for parents that watches their kids		

Concepts
Selection Process

In order to select five concepts from the seventy there were several factors considered including, ability to integrate interactive technology, severity of the problem being solved and how realistic was the solution.

Factors Considered

Ability to Integrate Interactive Technology

This project is answering the question "Can we positively augment the experience of running through the integration of interactive technology?" Therefore the final concept must include interactive technology.

Severity of the Problem

The severity of the problem was key to the selection process in order to ensure that the problem we are solving is worth the time and effort.

Realistic - Could it be made in the next 5 Years

The requirement of realism, or the ability to make this product in the next five years was a requirement created by the advisors on this project.

Selected Concepts

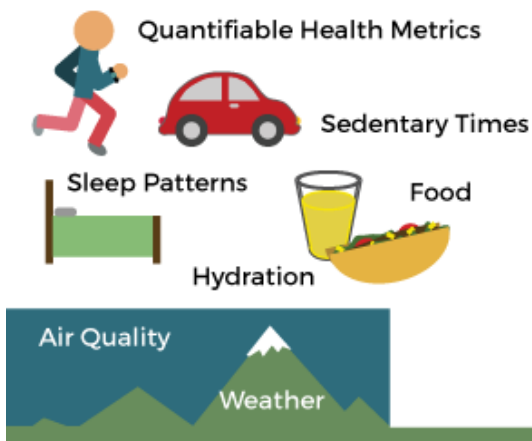| Name	Description	Problem	Severity Ranking	Insight(s)
Machine Learning Wearable & Mobile Platform	Mobile App and wearable platform tracks all data to understand how you injure yourself, tracks sweat, HR, Food, weather, work to understand how patterns affect your performance.	Injury, Re-Injury, Wieght Gain	5	Runners do not know how they are injuring themselves. Runner do not know how much they can eat in order to maintain and not gain weight. Runners like to self diagnose.
Running buddy	Running buddy Rolling or Drone carries your items, water, gels, pepper spray, has option of being weaponized	Storage, Safety, lost	2	Runners strategically plan routes so they can have access to water, gels, ect... so they do not have to carry it with them. Runners consider stafety from cars and humans alike. It affects their chocies and behaviors. This is more actute with women then men
AR Outdoor Glasses	AR Running glasses, gamification & virtual group runs	Boredom, Modivation, Lost	2	Running is very monotonous and runners are always looking for ways to entertain themselves. Almost all runner use headphones for music and podcasts when they are running along. Even in a group setting they desire entertainment and will play road trip games with their fellow runners. Community is very important for begginer runners to get them started and keep them running.
VR Runnnig Pod	VR multi sensory running pod, temp, smells, air flows over you, ground feels like real ground, gamification	Boredom, Extreme Weather, Modivation	2	The treadmill is a polarizing piece of equipment runners love it or hate it. The runners who do not enjoy it complain about the sterile enviornment, it is not temperature controlled and it is extremely monotonomous.
Vehicle VR	Autonomous vehicle running VR	Time, Boredom, Modivation, Extreme Weather	3	Runners complain that the time it takes to run is one of the greatest challenges

Problem : Injury | Severity : 5

INJURY PREVENTION SMART WEARABLE & MOBILE PLATFORM

① The wearable automatically collects all personal health and environmental information from the user on a daily basis.
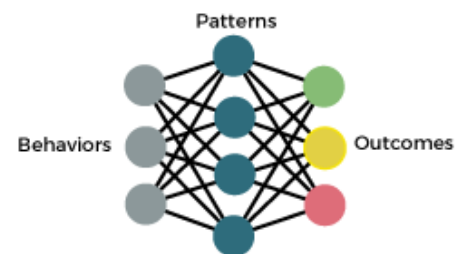
Including but not limited to:

Quantifiable Health Metrics

Sedentary Times

Sleep Patterns

Food

Hydration

Air Quality

Weather

② The user enters how they feel, physically and emotionally after every run into the mobile platform

④ The wearable & platform warns the user when they are at risk and teaches them what behaviors lead to injury.

③ Over time the platform learns how your behaviors and seemingly invisible patterns in life lead to injury

Patterns

Behaviors

Outcomes

The concept above demonstrates a product that helps runners prevent injury. The system gathers your information in multiple ways. First, while you are not running the system collects the data available through the smart device you are currently wearing. This smart device could be a watch, a cell phone, or whatever device we will utilize in the future. Then, before a run, the runner will mount the sensor platform to their body and the sensors will collect data on the runner's movements during the run. Finally, after the run the user will report how they feel and if they are feeling any pain in any particular part of their body. This feedback loop then allows the system to predict when the runner might injure themselves and warn them before they do.

Problem : Boredom | Severity : 2

AUGMENTED REALITY RUNNING GLASSES

Augmented Reality (AR) is a technology that overlays 3D images both static and dynamic into the world around you. These glasses will allow you to interact with the world in new ways as a you go on your run.

PLAY GAMES

RUN WITH FRIENDS NO MATTER THEY ARE

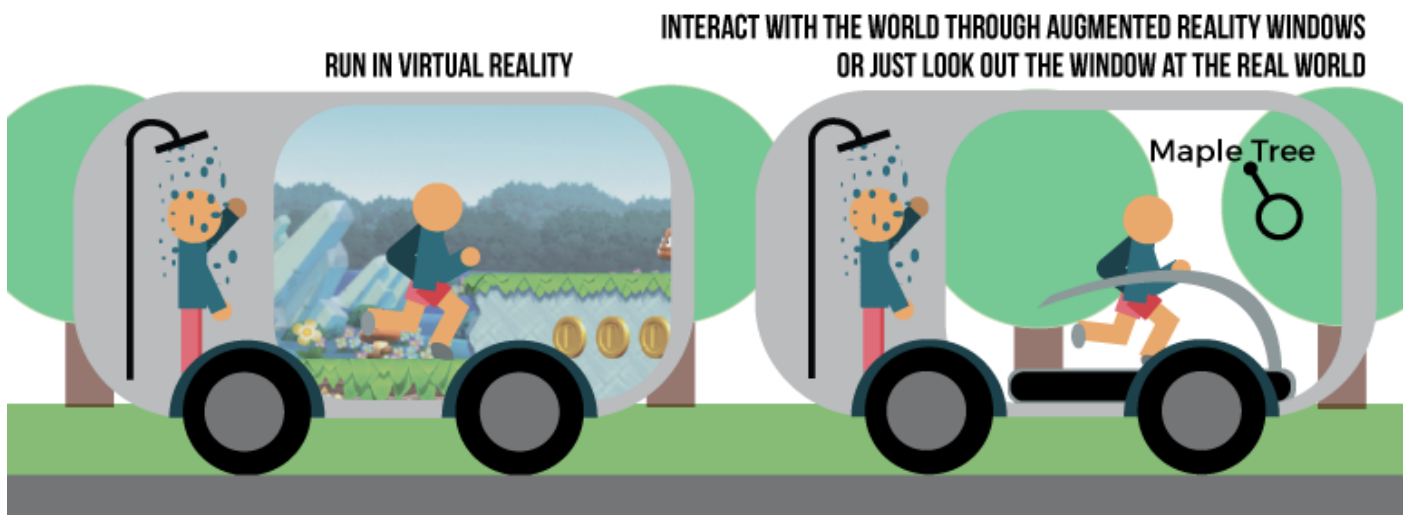**LEARN ABOUT THE WORLD**

Maple Tree

NEVER GET LOST

The concept above describes augmented reality glasses that allow runners to avoid boredom on long runs. It leverages augmented reality to overlay games, information, and even other runners into the world around them.

Problem : Time | Severity : 3

RUN COMMUTING - AUTONOMOUS VEHICLE SERVICE

① SUMMON THE AUTONOMOUS VEHICLE OR SCHEDULE REGULAR PICKUP

② RUN, SHOWER, CHANGE ON YOUR WAY TO WORK

RUN IN VIRTUAL REALITY

INTERACT WITH THE WORLD THROUGH AUGMENTED REALITY WINDOWS
OR JUST LOOK OUT THE WINDOW AT THE REAL WORLD

Maple Tree

The concept above solves the problem of not having enough time to go on a run. This concept allows the user to have more time by allowing them to multi-task by going on a run in an autonomous vehicle during their normal commute to work.

Problem : Boredom | Severity : 2

VIRTUAL REALITY RUNNING POD
You could have this pod in a gym or at home.
It immerses you in a virtual reality with no headset
required. Virtual reality is computer simulated 3D
environment that you can interact with.

YOU CONTROL
Temperature, Location (what you see), Sound, Scents,
and Oxygen levels (for altitude simulated training)

PLAY GAMES

EXPLORE
ON AND OFF EARTH

TRAIN WITH FRIENDS
OR IN A VIRTUAL CLASS

The virtual reality running pod solves the problem of boredom while running on a treadmill. The treadmill is a polarizing piece of equipment that allows runners to run in place indoors. This device enhances that experience by leveraging virtual reality to mentally transport the runner to another world and distract them from the fact that they are running on a treadmill.

Problem : Safety & Storage | Severity : 2

THE RUNNING BUDDY
CARRIES YOUR STUFF

Is a rugged long lasting companion for the runner who needs to carry food, water, mace, clothes or anything else. This device is semi autonomous, and avoids obstacles & people while staying close to you on your run.

GELS

WEAPON

ID

STAYS IN FRONT OF YOU WHEN YOU RUN

COMMUNICATES WITH YOUR HEADPHONES

LIGHT YOUR WAY

The running buddy is a semi autonomous vehicle that stays with you on your run and holds everything you need. Storage is a problem for runners because they need to carry water, fuel, and other personal effects on runs but they do not want to have to carry the additional weight.

Refined
Direction

I chose the injury prevention smart wearable platform as the final concept because the problem this concept was solving had the highest level of severity relative to the other concepts, indicating that it has the most potential to positively impact the lives of my users.

INJURY PREVENTION SMART WEARABLE & MOBILE PLATFORM

① The wearable automatically collects all personal health and environmental information from the user on a daily basis.

Including but not limited to:

Quantifiable Health Metrics

Sedentary Times

Sleep Patterns

Food

Hydration

Air Quality

Weather

② The user enters how they feel, physically and emotionally after every run into the mobile platform

③ Over time the platform learns how your behaviors and seemingly invisible patterns in life lead to injury

Patterns

Behaviors

Outcomes

④ The wearable & platform warns the user when they are at risk and teaches them what behaviors lead to injury.

Core Key Insight

Runners do not know how or when they are hurting themselves.

Market Research

Humon Blood Oxygen Tracker

Biometric Trackers

Humon has a product called Humon Hex that tracks the user's blood oxygen level. The device attaches to your leg via a strap, the product is primarily targeted at bikers but they include running in their value proposition (Dynometrics, 2018). I find this product interesting because this company decided to use a strap and, as you will discover later in this book, my research shows that runners do not want to wear straps when they run.

Machine Learning Wearables

Products that leverage machine learning are starting to hit the market in 2018. Ministry of Supply created a heated jacket that learns your body temperature preferences over time(Ministry of Supply, 2018). This product was kicked off using a successful Kickstarter campaign and shows that people are comfortable supporting machine learning systems that make their life easier.

Ministry of Supply Heated Jacket

Sensoria Smart Sock

Machine Learning Wearables

Wearable products, excluding smart watches, directly marketed to runners include gait and biometric trackers. These devices attach to the body of the runner and gives them feedback on how their body is performing. There are several gait trackers that have been on and off the market. Companies that are selling gait trackers including milestone pods and sensoria. Sensoria is interesting because they have socks with the sensors woven into the fabric of the socks (Sensoria, 2018). The continued existence and success of these products are important because they show that runners want to improve their running technique.

Position Aware Wearables

Claris Reflex Knee Tracker

There are wearables on the market today that are specifically tailored to understanding posture. These devices exist in the healthcare and athletics industries. There are several products on the market that monitor your posture through a wearable that vibrates when you hunch over. The technology behind these devices is simply a gyroscope, vibration motor and a battery. These products are important to note because one of the important factors in running is having proper posture.

Other more interesting products include The Nadi X yoga pant that have sensors built into the fabric of the pants and utilizes haptic feedback to help the user move into proper yoga poses (Wearable X, 2018). In the medical field the company Claris Reflex has developed technology to monitor and track the knees of knee replacement patients. Their technology tracks the healing process of the patient by mounting two sensors, one above and one below the knee. Together the sensors monitor the knee and the healing process (Claris Healthcare, 2018). This device is important to mention because it is very similar to the final concept presented in this project shows that this technology is in demand.

Navigation Wearables

Project Jaquard Jacket

There are many products on the market solely focused on helping the user navigate the world around them. Lechal and Smartsole both provide shoe soles that contain GPS functionality but target different demographics. Lechal targets a main stream client and provides a product that vibrates the soles of their feet to give directions to their users (Lechal, 2017). Smartsole allows their clients to track the location of elderly adults and children that they are taking care of (Smartsole, 2018). These products are important to note because they are failures. Lechal's product did not catch on in the market and I think it shows that underfoot interventions are complex and I should stay away from that space.

The most interesting product in this category is Levi's project Jaquard Jean Jacket that provides a fabric interface that allows you to controls your phone (Google, 2018). This project is an amazing testament to how research can be implemented in the real world and it shows how interaction design is moving into the future.

Problem
Injury

Runners do not know or when they are injuring themselves. There are two types of injuries that occur, acute injury caused by a single event and injuries caused over time through over use and long term wear and tear of the body. The Injury Prevention Smart Wearable & Mobile Platform concept is focused on injuries that occur over time.

Overuse injuries are being targeted because our research shows that runners will run until they are critically injured and cannot run at all. Typically runners will experience pain and write it off as a normal feeling until the pain becomes unbearable. The Injury Prevention concept allows the runners to track, understand and be warned that the pain they are experiencing in conjunction with their behaviours could lead to injury.

Concept is Focused on Overuse Injuries

Most common running injuries occur at the hip, thigh, knee, shin and foot.
(Mayo Clinic, 2018)

Common Runner Injuries

Most Common Injuries for Runners

| Injury Name	Pain Location	Cause	Signs	Prevention	Risk Factors
Runner's Knee/patellofemoral pain syndrome	Front of knee	--Overuse - Muscle imbalances or weaknesses - Injury - Surgery	-Dull, Aching pain in the front of your knee when you walk up or down stairs, kneel or squat, or sit with a bent knee for long periods of time	- Maintain Strength - Think Alignment and technique - Lose excess pounds - Warm Up - Stretch - Increase Intensity Gradually - Practice Smart Shoes	-Age -Sex(female more likely) -Certain Sports
Achilles Tendinitis	Back of Ankle	Caused by repetitive or intense strain on achilles tendon more susceptible if you have suddenly incresed the intensity of your running program	-Mild ache in the back of leg or above the heel after running - -Episodes of more severe pain may occur after prolonged running, you might also experience tenderness or stiffness especially in the morning, which usually imporves with mild activity	-Increase your activity level graudally -Take it easy -Choose your shoes carefully -Stretch daly -Strengthen your calf muscles -Cross train	-Sex -Age -Physical Problems-flat arch, obesity, tight calf muscles -Training choices - worn out shoes, cold & warm weather, hilly terrain -Medical conditions - psoriasis or high blood pressure -Medications - antibiotics, fluoroquinolones
Plantar Fasciitis	Bottom of foot near heel	Under nomal circumstances your plantar fascia acts like shock absorbing bowstring, supporting the arch in your foot. If the tension and stress on that bowstring become too great, small tears can arise in the fascia. Repetitive streching and tearing can cuase the fascia to become irritated or inflamed, though in many cases of plantar fasciitis the cause isn't clear.	Stabbing pain in the bottom of your foot near the heel. It usually the worst with the first few step after awakening, althought it can be triggered by long periods of standing or rising froom sitting the pain is usually worse after exercise not during it.		-Age -Certain types of exercise -Foot mechanics- flat footed or abnomal pattern of walking -Obesity -Occupations that keep you on your feet
Medial tibital stress syndrome/ Shin splints	Front Lower Leg	Intensification or change of training routine, the increased activity overworks the muscles, tendons and bone tissue.	Tenderness, soreness or pain along the inner side of your shinbone and mild swelling in your lower leg, at first the pain might stop when you stop exercising. Eventually, however, the pain can be continuous and might progress toa stress reaction or stress fracture.	- Analyze your movement - Avoid Overdoing - Choose the right shoes - Consider Arch Supports - Consider Shock absorbing insoles - Lessen the impact - Add Strength training to your workout - exercises to strengthen and stabalize, legs, ankles, hips	-If you are a runner -Sudden increase the duration, frequency or intensity of exercise -Running on uneven terrain -You are in military training -Flat feet or high arches
Iliotibal band syndrome	Lateral Knee pain	Tough band of tissue that extends from the outside of your hip to the ouside of your knee becomes so tight that it rubs against the outer potion of your femur	Lateral Knee Pain		
Stress Fracture	Specific spot	Repetitive force often from overuse. Increasing the amount of intensity of an activity too quickly	You might barley notice it at first but it tends to worsen with time. The tenderness usually originates from a specific spot and decresases during rest. You might have swelling around the painful area	Proper recovery time Make changes slowly Use proper footwear Cross -train get proper nurition	-Certain Sports -Increased Activity -Sex (female) -Foot problems- flat feet or high arches -Weakened bones -Previous Stress Fractures -Lack of Nutrients
Patellar Tendinitis	Between kneeca where tendon attaches to your shinbone	common overuse injury, caused by repeated stress on your patellar tendon, the stress results in tiny tears in the tendon, which your body attempts to repair. But as the tears in the tendon multiply, they cause pain from inflammation and weakening of the tendon. When this tendon damage persists for more than a few weeks its called tendinopathy.	The pain in your knee may at first be present only as you begin physical activity or just after an intense workout worse until it interferes with playing your sport eventually interfere with daily movement such as climbing stairs or rising from a chair	Dont play through pain Strengthen your muscles Improve your technique	Physical Activity Tight Leg Muscles Muscular Imbalance
Ankle Sprain	Ankle	A sprain occurs when your ankleis forced to move out of its normal position, which can cause or or more of the ankle's ligaments to strech, paritally tear or tear completly. Causes: -A fall that causes your ankle to twist -Landing awkwardly on your foot after jumping or pivoting -Walking or exercising on an uneven surface -Another person steppnig or landing on your foot during a sports activity	Pain, especially when you bear wieght on the affected foot tenderness when you touch the ankle Swelling Brusing Restricted range of motion Popping sensation or sound at the time of injury	-Warm up before you exercise or play sports -Be careful when walking, running or woking on an uneven surface -Use an ankle support brace or tape on a weak or previously injured ankle -Wear shoes that fit well and are made for your activity -Minimize wearing high-heeled shoes -Don't play sports or participate in activities for which you are not conditioned -Maintain good muscle strength and flexibility -Practice stability training, including balance exercises	-Sports participation -Uneven surfaces -Prior ankle injury -Poor phyical condition -Improper shoes

(Mayo Clinic, 2018)

What Each Sensor Monitors

Users do not need to wear every sensor.

Each sensor as well as sensor combinations monitor different injury locations on the body.

Sensor Mounting Location	Body Region being Monitored
Nape	Back - Posture
Nape & Waist	Back - Posture
Waist& Thigh	Hip
Thigh	Illiotibal Band
Thigh	Foot - Strike Pressure
Thigh & Shin	Knee
Shin	Shin - Shin Splints
Nape, Waist, Thigh, Shin	Full Body - Posture & Symmetry

Note: Shin Splints is a catch-all term for pain in the shin
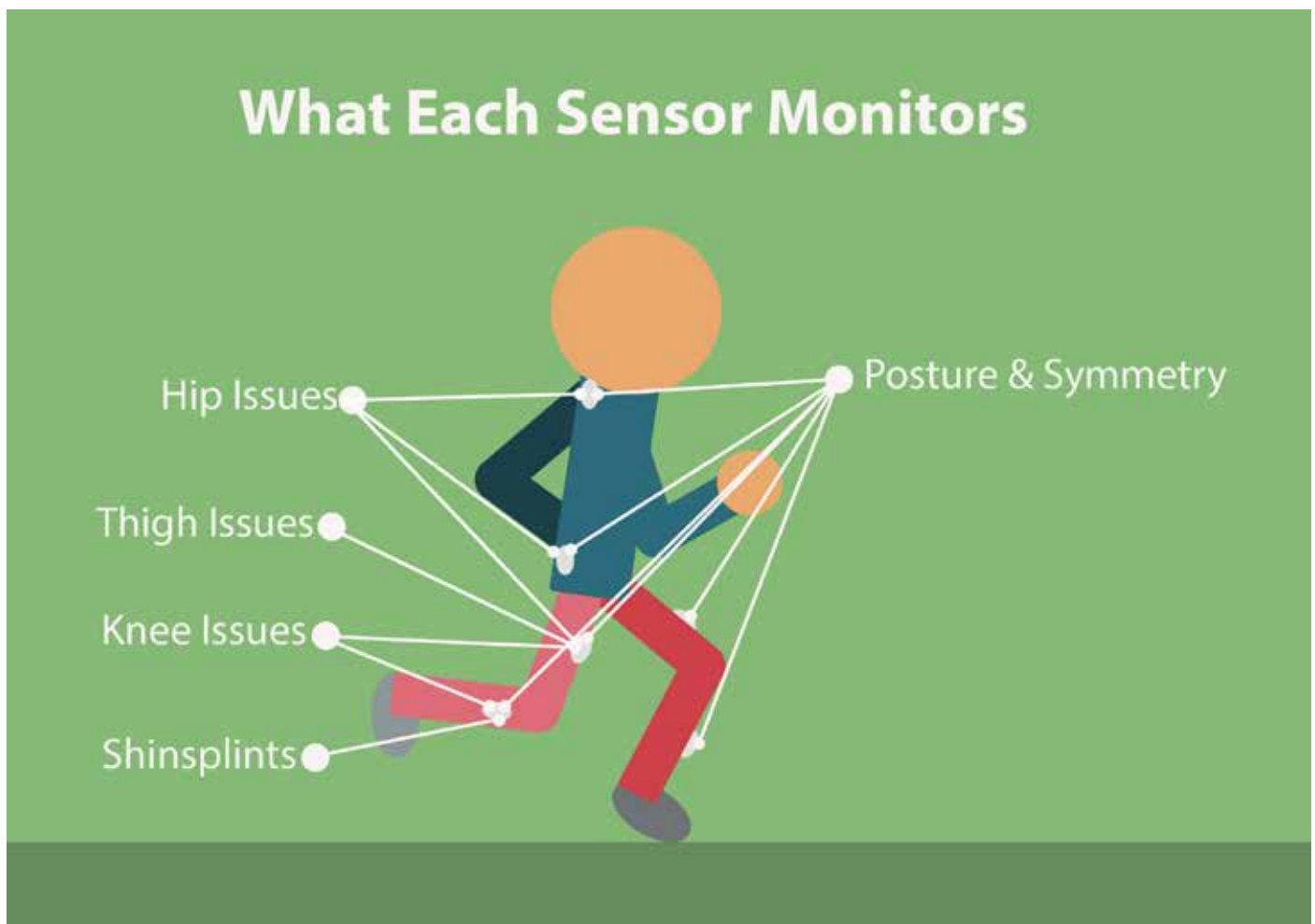
How the Tech is Worn

Mounting the sensor

A critical element of this design is mounting the sensor to the runner. The research from this project has indicated that runners are concerned with chafing, heat, weight, washability, and proxemics of a wearable product. Even though their concerns are generally the same, every runner has a slightly different way of wearing running gear. The research also indicated that the type of gear worn by runners changes throughout the year depending on the weather and temperature of their environment.

Based on this information we learned that it is not wise to dictate how a runner mounts the wearable to their body. Instead, we should provide multiple options for mounting the wearable to the runner. A good comparison that exists in the market today are GoPro products. GoPro provides a single device and how you mount that device to your body depends on user preferences, with options sold separately.

These wearable mounting options include and are not limited to straps, sleeves, adhesives directly on the skin, pants with built in pockets, mounting clips, and attachment kits so you could mount the sensor to your favourite piece of preexisting gear. The research conducted in this project did not indicate the best way to mount these sensors to a runner, however, this topic should be explored in a future project.

Guiding Principle
Do not tell runners what to wear

Mounting Options
Garment to Body

In order to attach electronics to the body you must attach the electronics through a medium like a garment to the body. Therefore, there are two elements that must be considered the garment and the way the sensor attaches to that garment. Below are examples of how the garment could interface with the body and to the right are examples of how the sensor could interface with the garment.
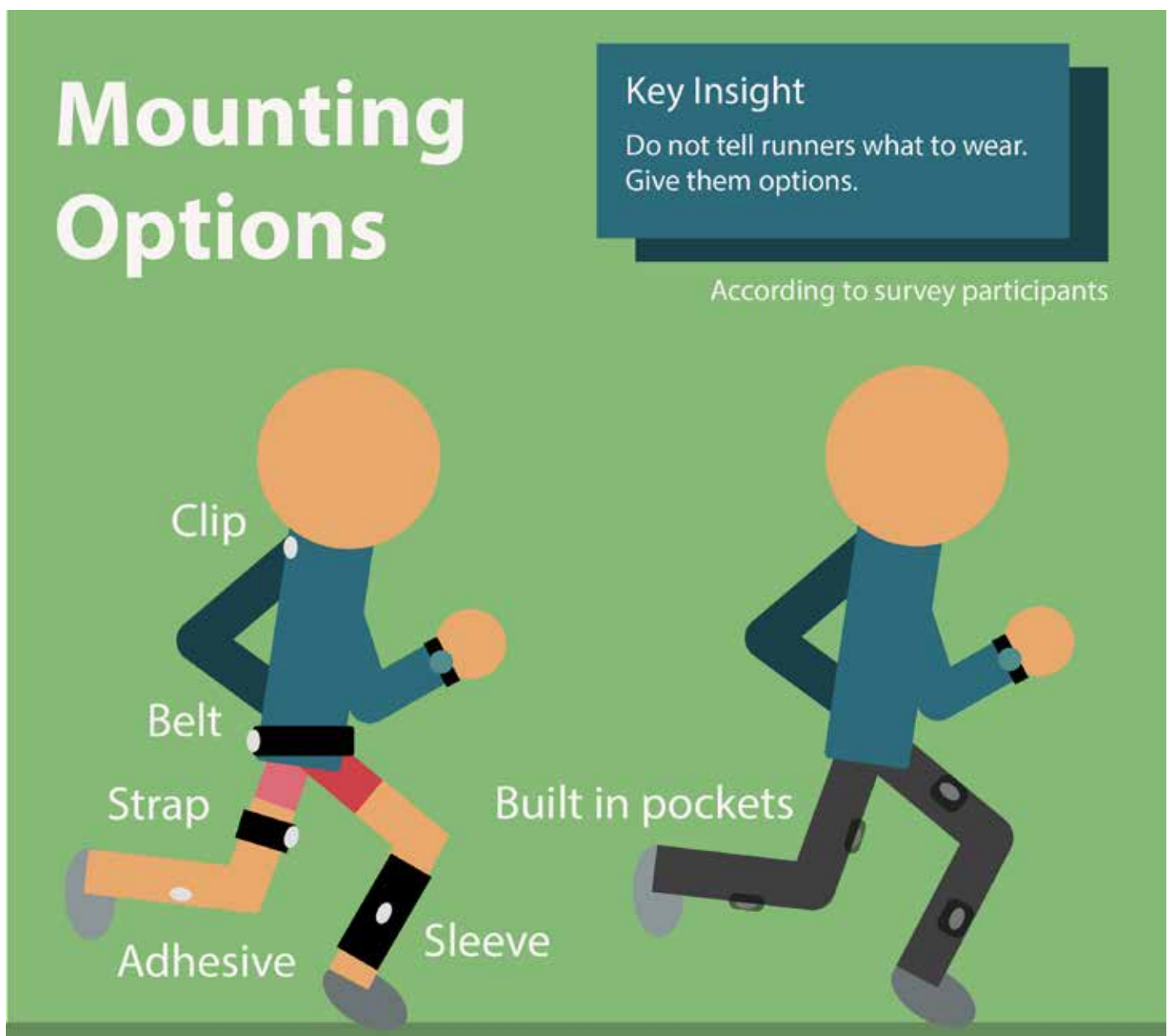
Attachment Options

Sensor to Garment

Snaps

Magnets

Clip

Adhesive

Zipper

Elastic

Velcro

Proposed System

The Parts of the system

The Preexisting Wrist-Mounted Wearable

This system does not include a watch or a wrist-mounted wearable because the smart watch product market is saturated. Products on the market include the Apple watch, Pebble, and Samsung smart watch products. All of these products gather and disseminate data to applications so that the user can use that data however they want. Our application uses the available data from whatever smartwatch the user already owns to gather and process information so that we can have a better understanding of how the runners' daily activities affect running outcomes.

The Carry Case

The carry case charges the sensor pods and allows all of the pods to pair with the application via Bluetooth through the press of a single button.

Sensor Pod

The pod gathers and stores accelerometer and gyroscopic data, then passes that information via Bluetooth to the application. Once the data is uploaded the pod clears its storage space to make room for new data.
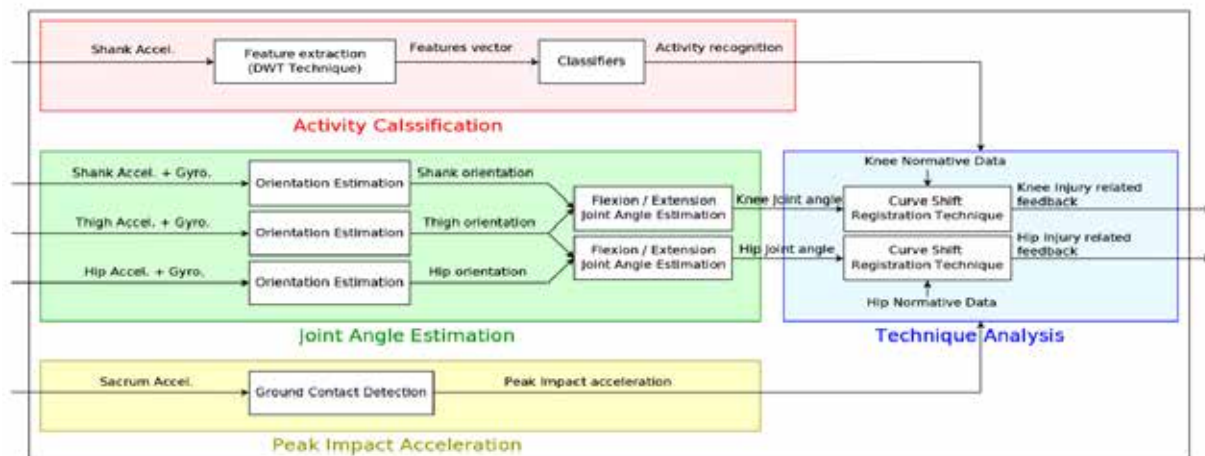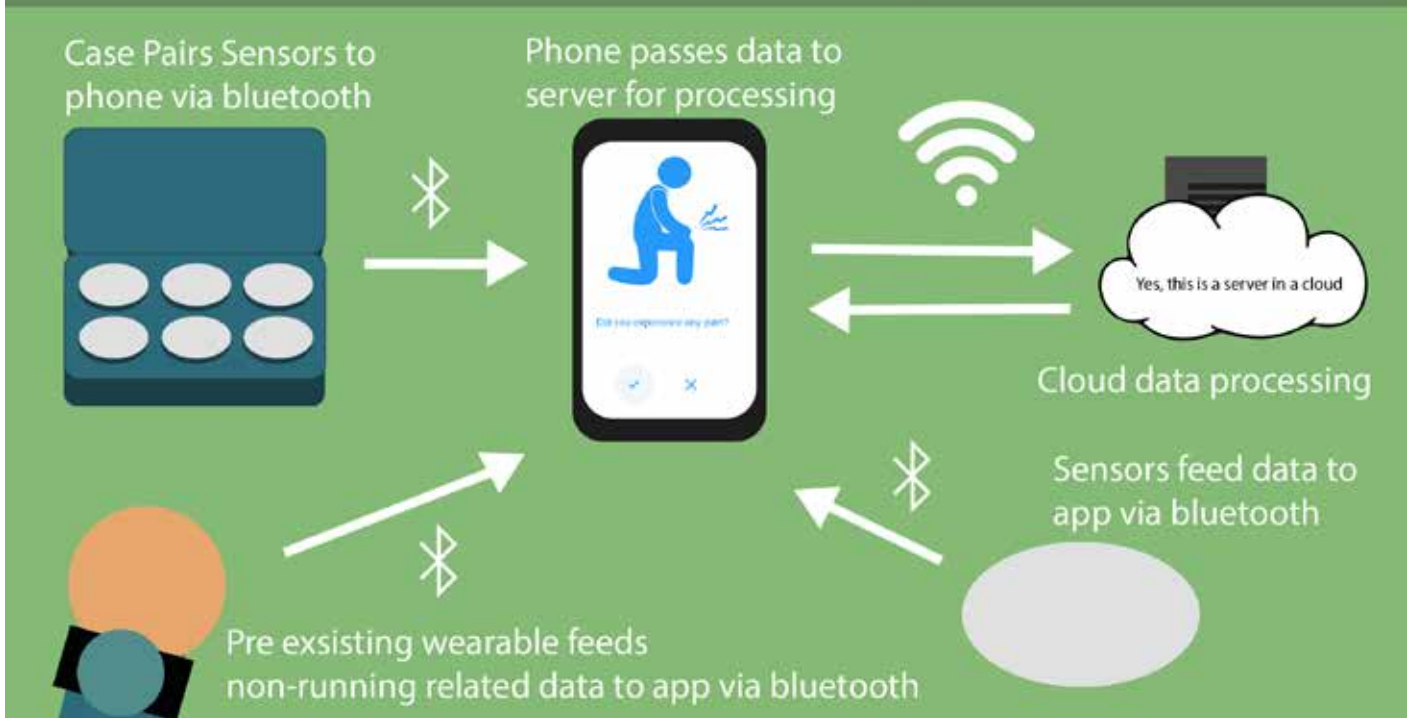
Server

For this system to have an optimal user experience we leveraged cloud data storage and processing. If the storage and processing was on the user's phone it would considerably slow down the speed of their phone which would lead them to stop using the product altogether.

Data Processing - Machine Learning

This server takes the data and discovers how and when you might hurt yourself by utilizing machine learning algorithms. Researchers from the Dublin City University were able to successfully classify various activities with 98% accuracy by utilising machine learning. They used a Discrete Wavelet Transform in conjunction with a Random Forest Classifier to classify the data gathered by a wearable sensor platform that collected accelerometer data from athletes (Ahmadi, 2014). They showed they were able to distinguish injured athletes from non-injured athletes by comparing their data to normative data sets (Ahmadi, 2013). This study is relevant to the product concept because it shows the back-end software of the product can be made. In addition, this study also acted as a framework for where the sensors should be mounted on the body.

How it works - Networking & Data Flow

Case Pairs Sensors to phone via bluetooth

Phone passes data to server for processing

Yes, this is a server in a cloud

Cloud data processing

Sensors feed data to app via bluetooth

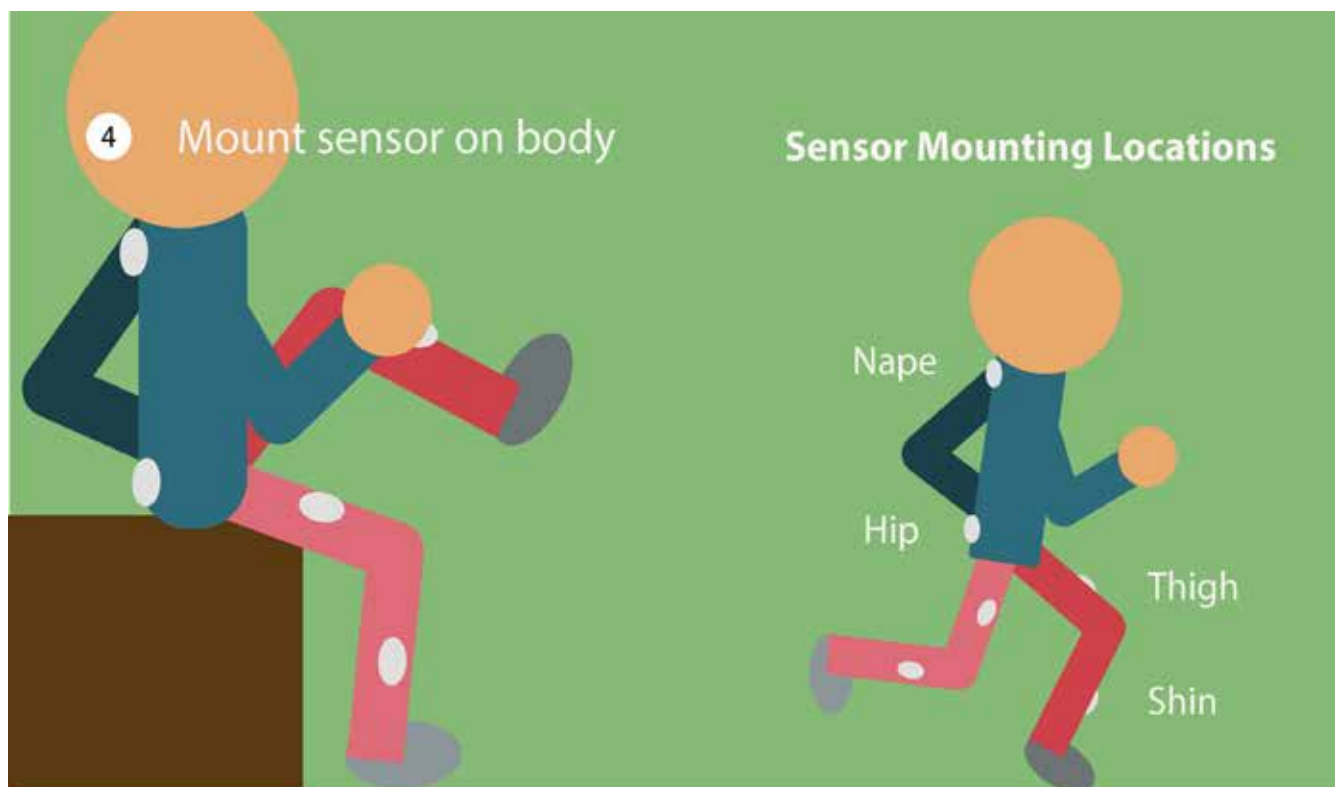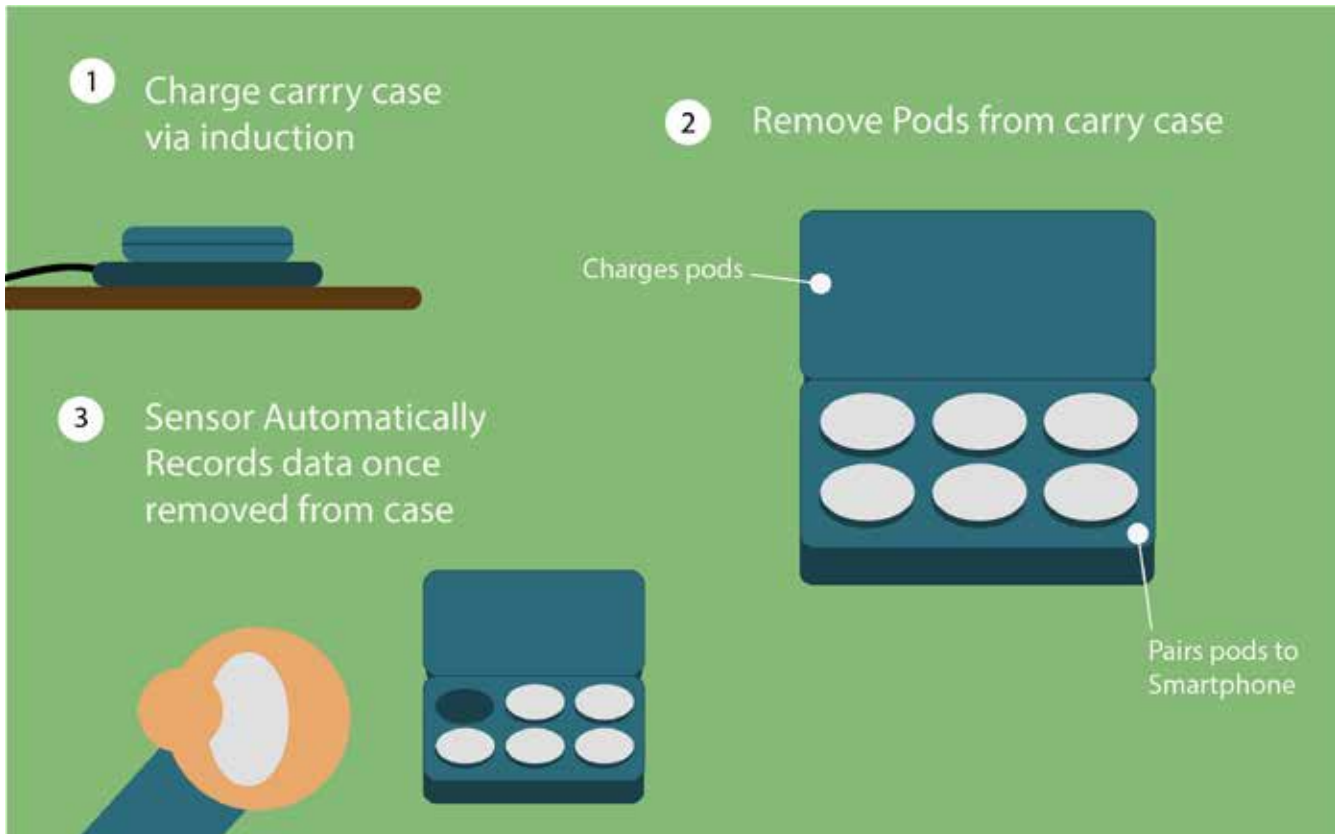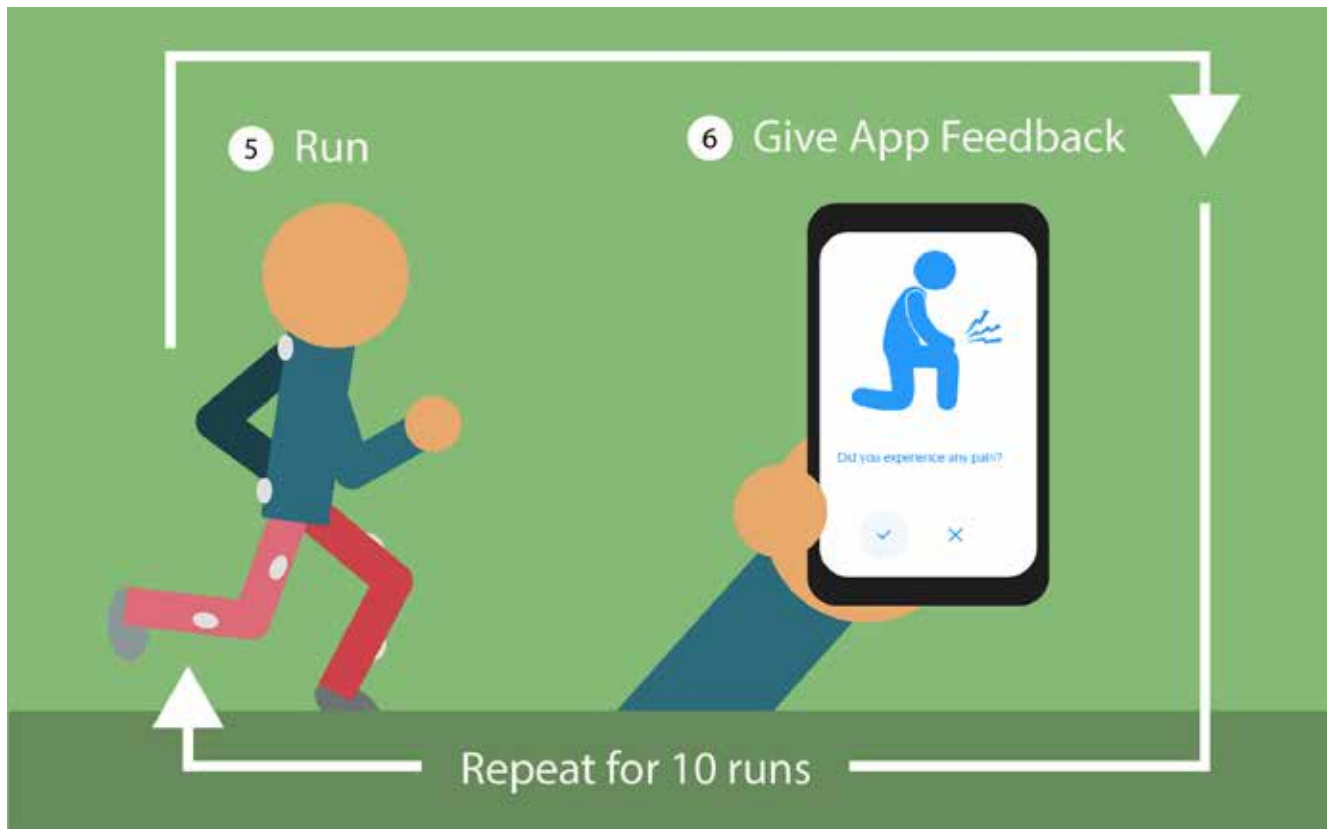Pre exsisting wearable feeds non-running related data to app via bluetooth

Excerpts from "Towards Automatic Classification and Movement Assessment During a Sports Training Session." (Ahmadi, 2014) The flow of turning data into injury related feedback pictured above. Sensor mounting locations pictured to the right.
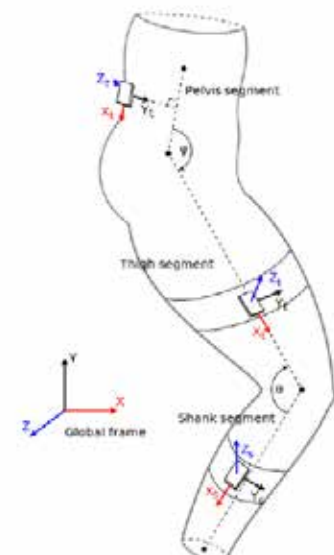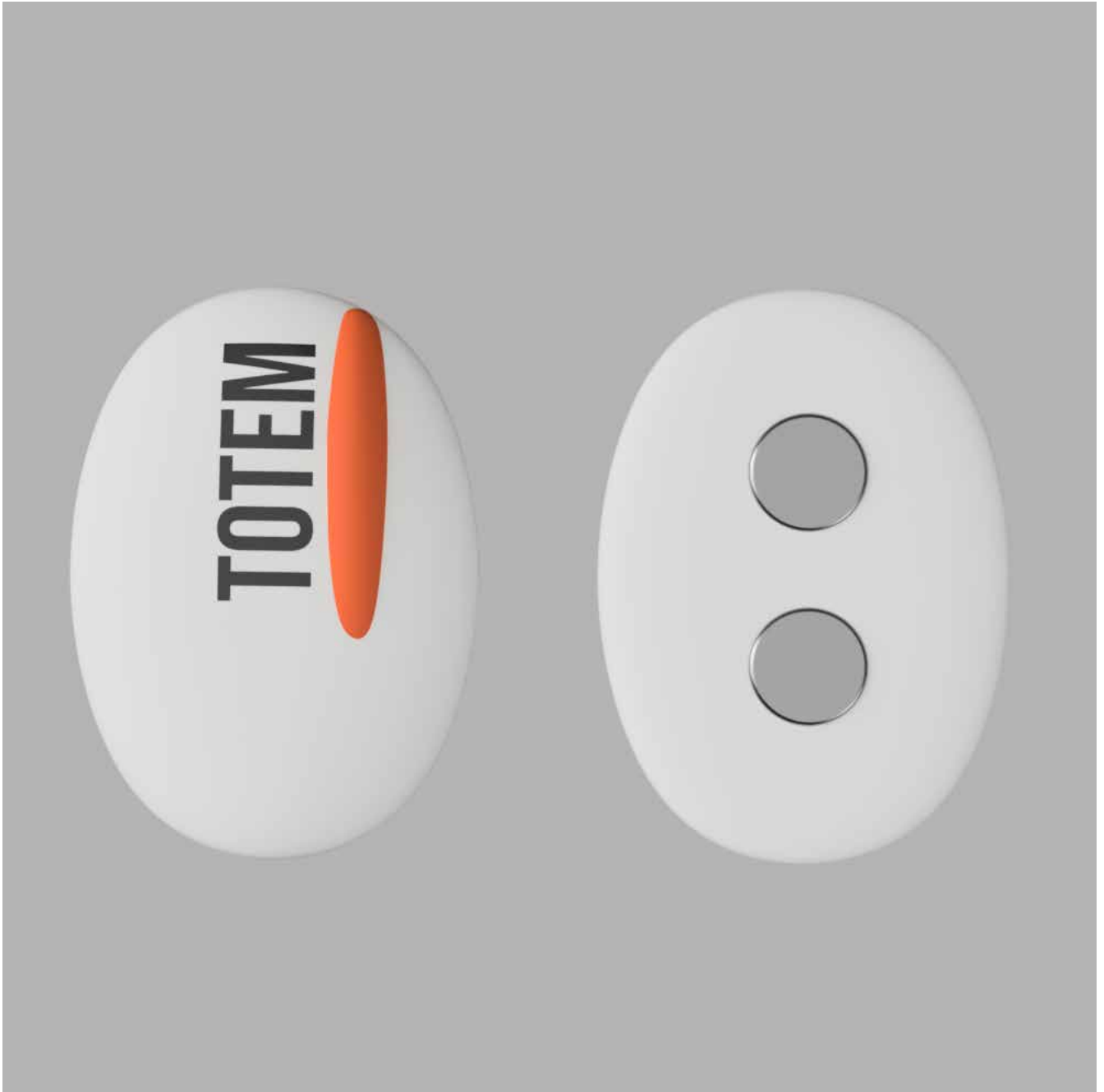
Product System

The illustrations below give a detailed view of how the system operates from the user's perspective.

1 Charge carrry case via induction

2 Remove Pods from carry case

Charges pods

3 Sensor Automatically Records data once removed from case

Pairs pods to Smartphone

4 Mount sensor on body

Sensor Mounting Locations

Nape

Hip

Thigh

Shin

Design of the Sensor

Design Criteria
## Parameters of Wearable Technology

Electronics
Minimum Volume Limit   0.077in3

The embedded electronics in this device created a hard limit for how small this device could be. The internal components required to make this device function included an accelerometer, gyroscope, lithium ion polymer battery, memory storage card, vibrating motor, PCB, button, and LEDs. To determine the volume of each component I sourced the components from manufacturers and found the correct size specification. The minimum volume dictated by the internal components can be described by .14" (height) x 1" (length) x .5" (width) or .077in3.

Proxemics
Maximum Height   0.5in

Proxemics is the human perception of size and it is important because objects placed on the human body should not extend past a certain limit. The human body perceives itself to be slightly larger than it is to help us avoid bumping into objects (Zeagler, 2017). Objects that are placed on the body should remain within the limits of human proxemics so that they are immediately comfortable to wear on our body. The height of the sensor being developed in this project should not exceed 0.5 inches due to the fact that two of the sensors in this system must be worn on the shin and the proxemic limitation at that point is half an inch. The image below is an excerpt from Zeagler's paper "Where to Wear It: Functional, Technical, and Social Considerations in On-Body Location for Wearable Technology," showing the proxemic limitations of human beings on different locations of their body.
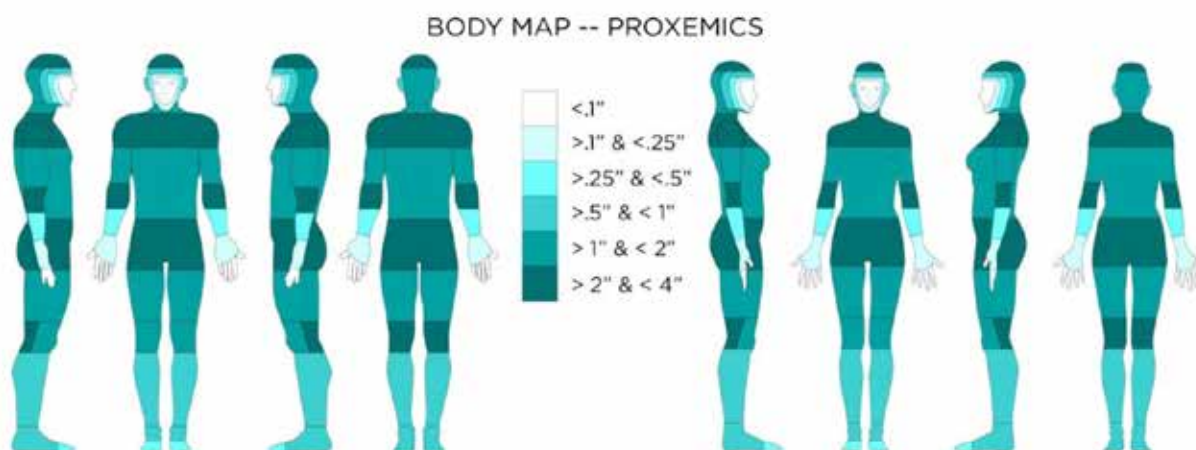
Proxemic Body Map (Zeagler, 2017)

Wearability
Humanistic form language dictates curved edges
The design of the sensor must take into account humanistic form language, simply meaning that all of the edges of the object must be curved to ensure the comfort of the user (Gemperle, 1998).

Universal Design
Simplicity and clarity are key to success
A key part of making any design successful is making it easy to use. The design of the sensor must be simple and easy to use for a first time user of the product. One complexity of this sensor platform is that there are six different sensor mounting locations and each sensor must go in the correct spot. This design must clearly indicate where each sensor should be mounted.

Functionality
Mounting Locations
This project is strongly supported by the work completed in the paper "Towards Automatic Activity Classification and Movement Assessment During a Sport Training Session" (Ahmadi, 2014). This paper shows that six sensors that should be mounted on the body: one on each shin, one on each thigh, one on the waist, and one on the torso (Ahmadi, 2014).

Washabilty
Can be washed after every run
The research indicated that runners want gear that is easy to wash. Thus, the device must integrate into the way they currently wash their clothing. In addition, the users require that the gear the sensor mounts to must be washable after every run.

Brand Identity
Simple, Clean, Friendly

Due to the fact that this device is collecting personal data, I want the sensor to feel trustworthy.
It should feel more like big mother than big brother.
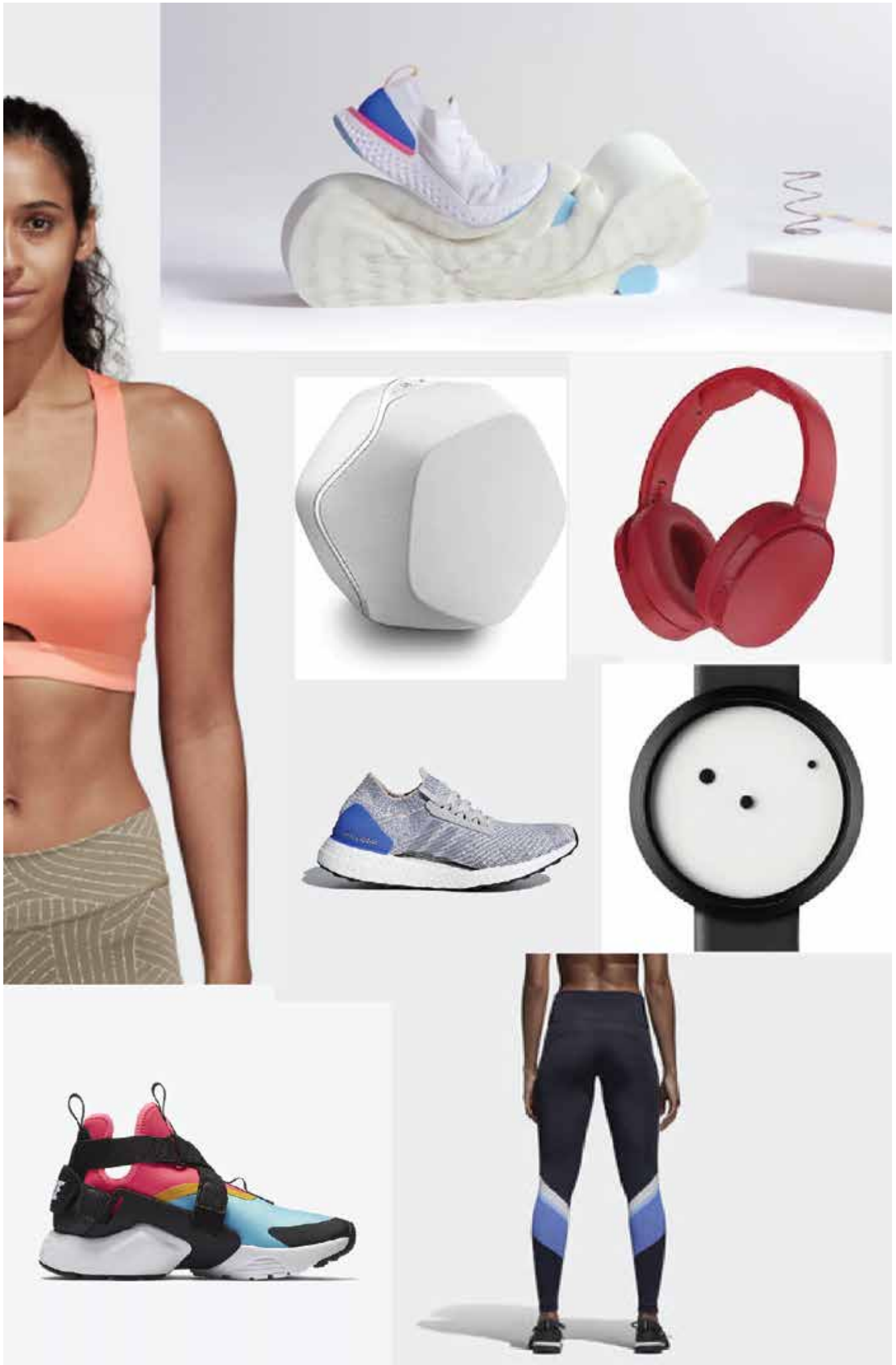
Color Pallete

#DC5F73

#F16122

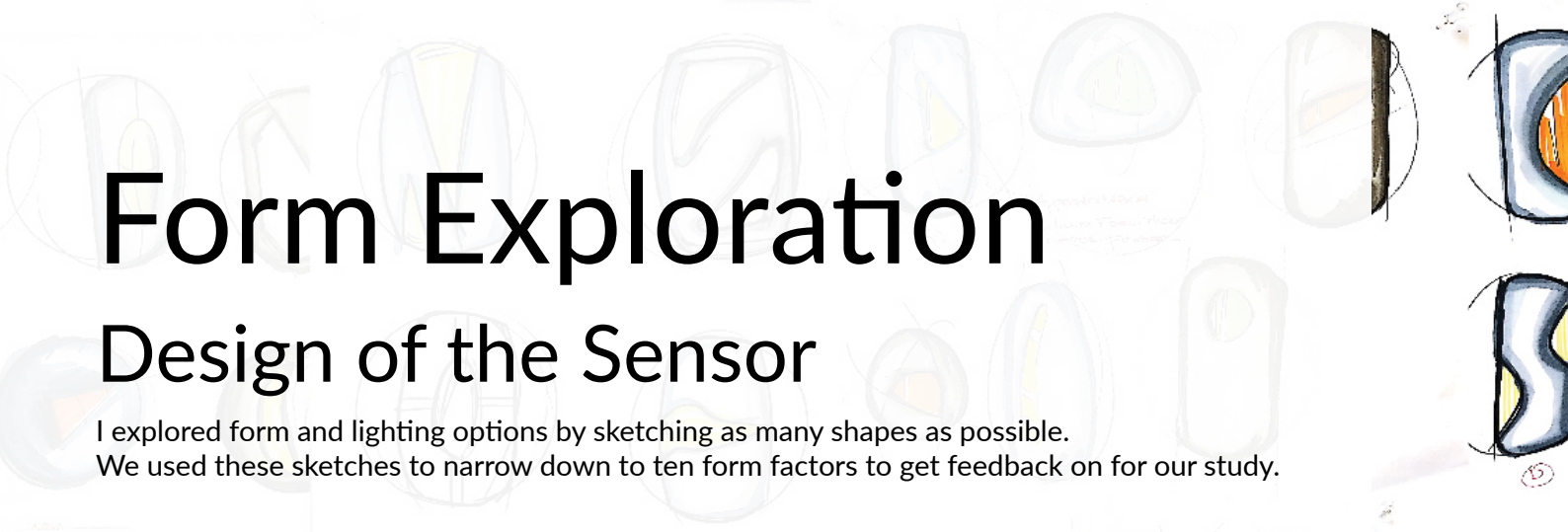#A3CDD5

#E9ECED

Branding

Product Name

Totem

ˈtōdəm/
Definition: a natural object believed by a particular society to have spiritual significance and adopted by it as an emblem.
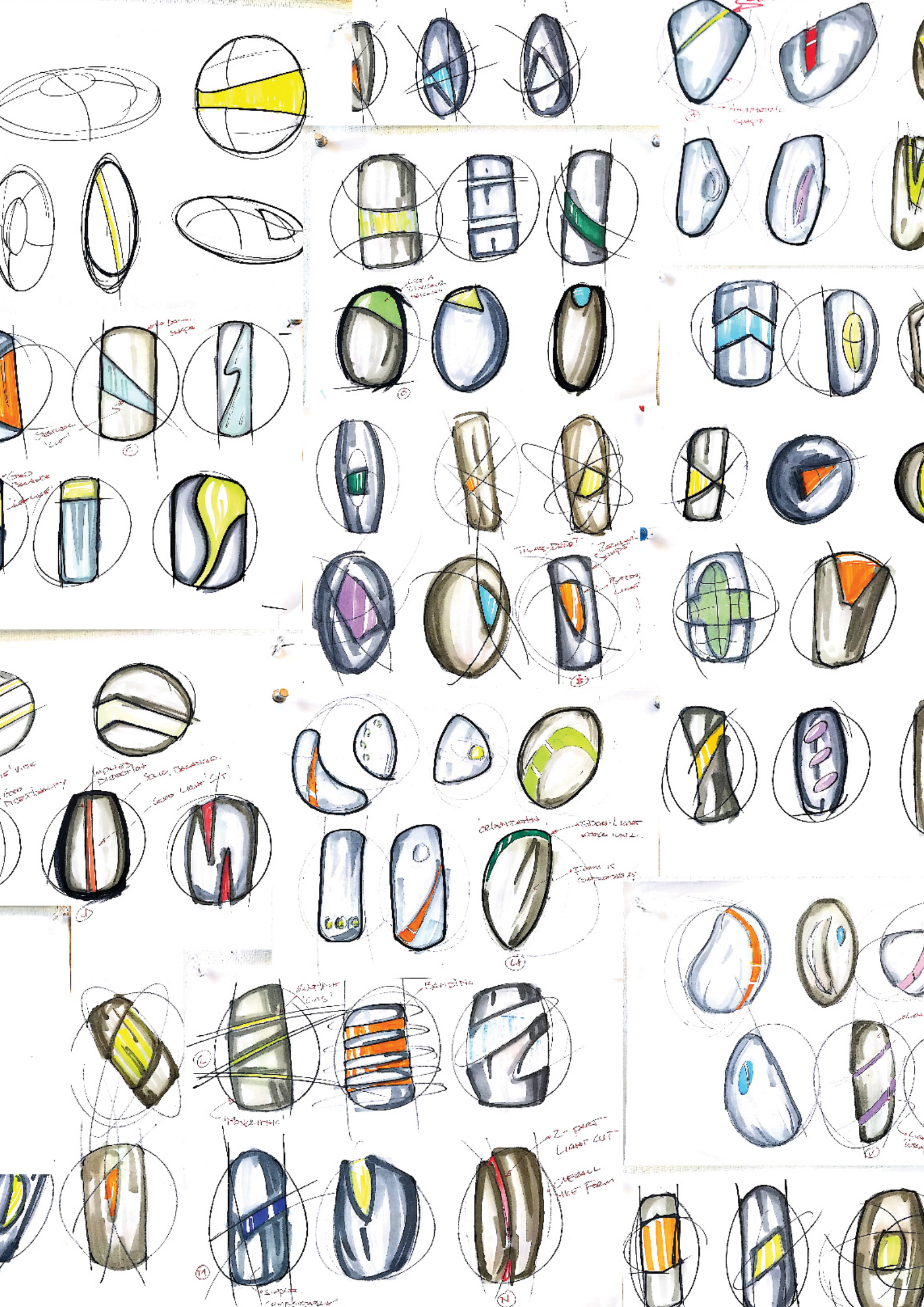
Form Exploration

Design of the Sensor

I explored form and lighting options by sketching as many shapes as possible.
We used these sketches to narrow down to ten form factors to get feedback on for our study.

Final

User Study

To evaluate the prototypes created we conducted a study where we got feedback from eight runners. This study was used to inform the final form factor and functionality of the sensors, the application, and the mounting system.

Evaluated

Product Concept

Sensor Forms

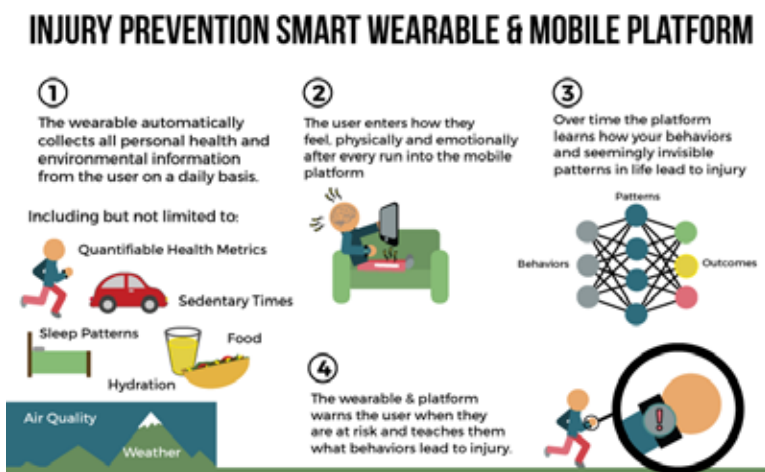**Mounting System**

Mobile Application
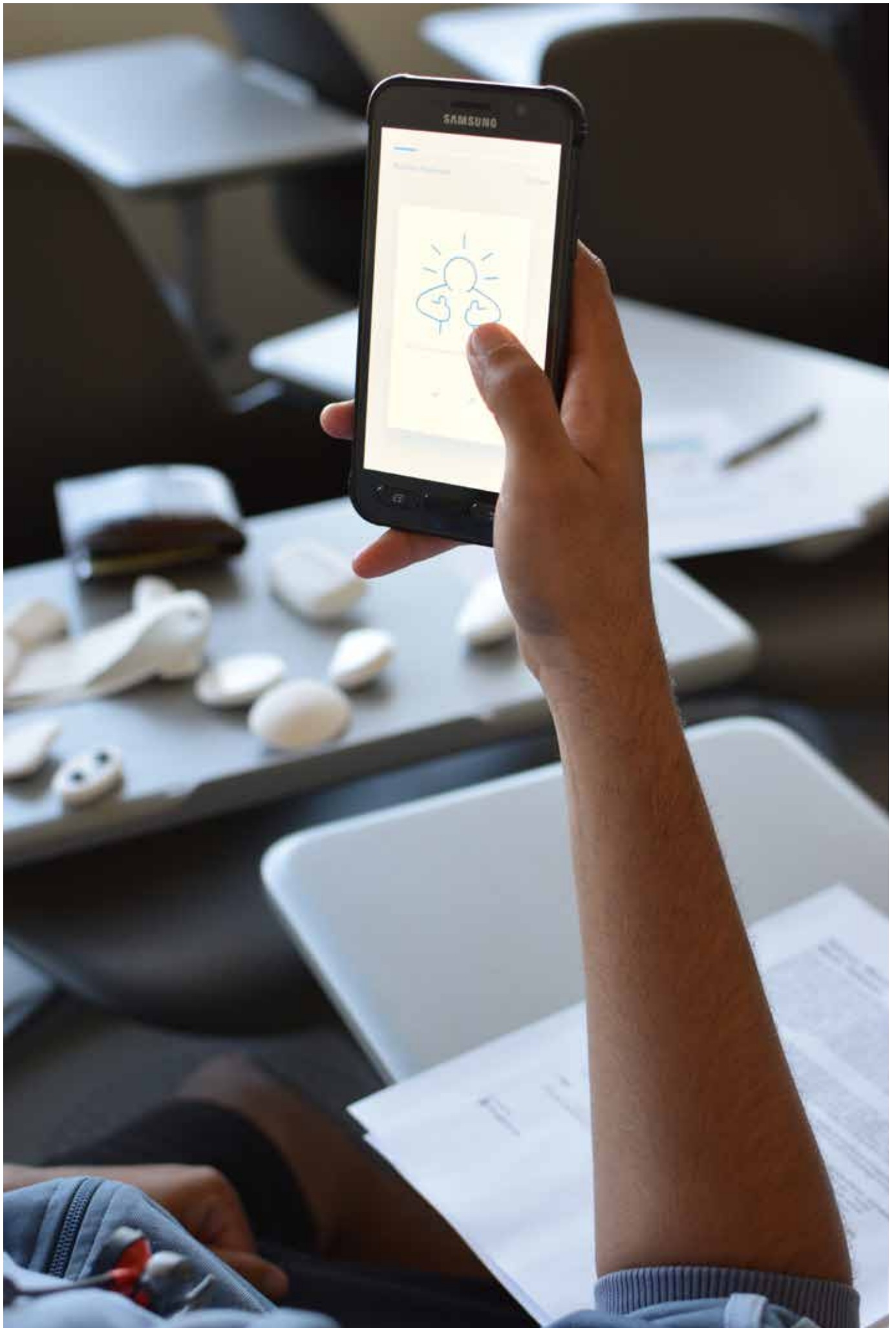
User Study

Methodology

For this study the researchers presented the prototypes for evaluation to the participants. The participants reviewed the prototypes and participated in a semi-structured interview. For a detailed view of the procedures and interview prompts please see Appendix C.

Concept Introduction

The concept of the product was first presented to the participant so they could review it.

INJURY PREVENTION SMART WEARABLE & MOBILE PLATFORM

① The wearable automatically collects all personal health and environmental information from the user on a daily basis.

Including but not limited to:

- Quantifiable Health Metrics
- Sedentary Times
- Sleep Patterns
- Food
- Hydration
- Air Quality
- Weather

② The user enters how they feel, physically and emotionally after every run into the mobile platform

③ Over time the platform learns how your behaviors and seemingly invisible patterns in life lead to injury

Patterns
Behaviors — Outcomes

④ The wearable & platform warns the user when they are at risk and teaches them what behaviors lead to injury.

Sensor form Evaluation

The participant was presented with ten sensor prototypes in a random order. The participants were then prompted to interact with the forms and talk about which shapes they preferred.

Mounting system Evaluation

The participants were then introduced to the mounting strap provided. It was optional for participants to wear the mounting strap.

Application Evaluation

The participant was introduced to a tap-through prototype that simulated providing feedback.

User Study

Semi-Structured Interview

After the participant had interacted with all of the prototypes the researcher conducted some follow up questions on the successes and failures of each prototype.

Final Question

Would this product positively augment your experience of running?

This final question was asked in an attempt to understand if the concept and design of this system was successful.

User Study

Sensor Forms

Forms

The sensor design was narrowed down to these ten final form factors. These forms were then evaluated in the user study.

Participant Sorting behaviour

A majority of participants grouped the sensors based on their preferences.

Results

Each participant gave feedback on which sensor they preferred as well as the type of feedback they would like from this device.

Sensor Form
Preferred Sensors: 1, 4,6 and 7

Each participant was asked to pick their favorite form resulting in a four way tie between sensors 1, 4, 6, and 7. All four sensors had common features which are discussed below.

Important features according to participants

Lightweight: The sensor must weight as little as possible

Low Profile: The sensor must be as flush to the skin as possible

Feel: The sensor must feel good in my hand

1

3

4

5

6

7

8

9

10

11
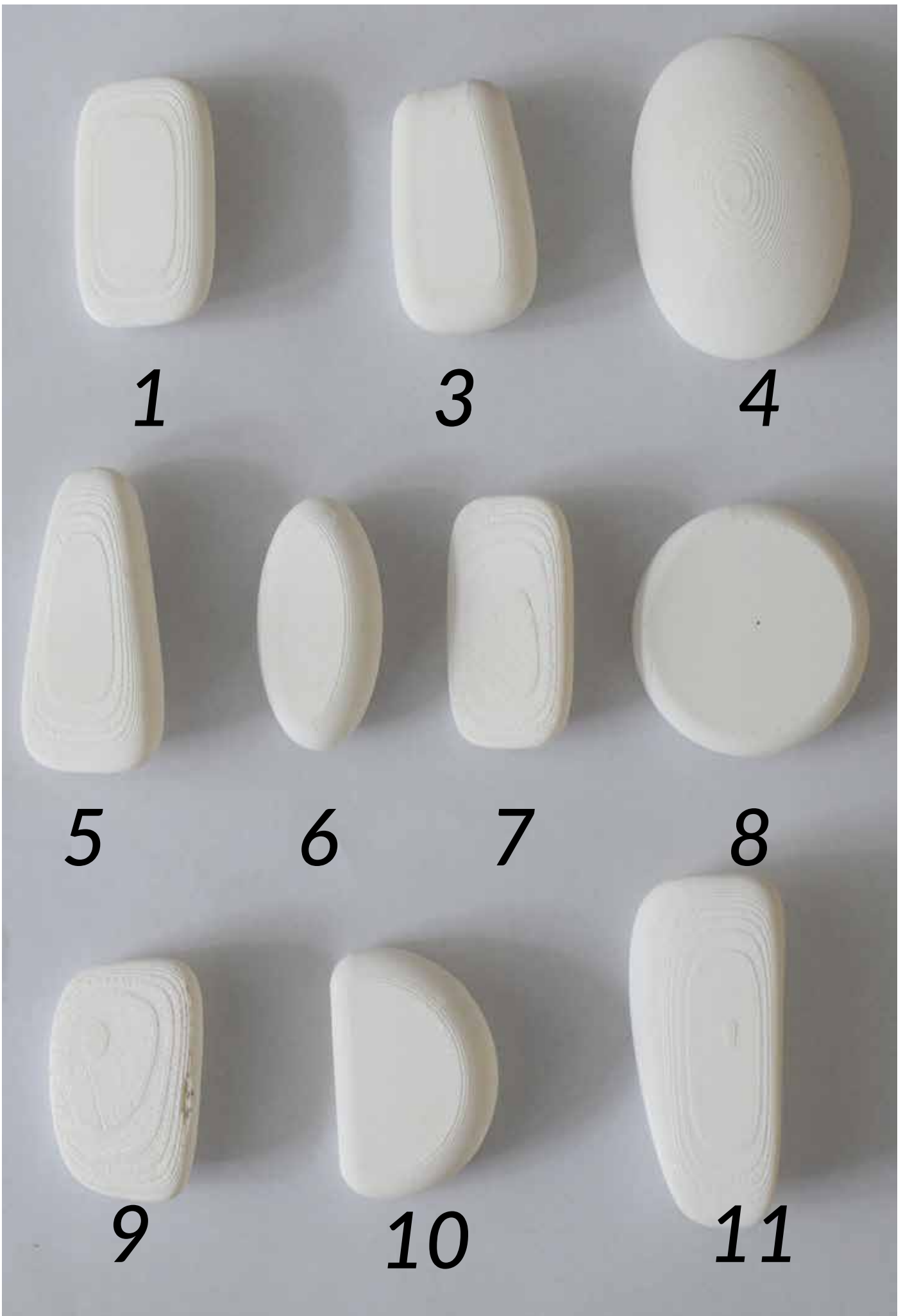
User Study

Mounting Strap

The participants were invited to try the mounting strap and discuss what kind of mounting system they would prefer.

Results

The participants did not like the strap

Successes
The Snap-on Interface

The participants enjoyed the simplicity and robustness of the snap-on interface between the strap and the sensor.

Improvement Areas
Participants hated the strap

Participants were worried about the strap sliding down their leg and causing chafing. The participants wanted the sensor to be mounted to a sleeve, or adhesive directly to the skin or spandex pants.

User Study

Application

The participants tapped through an application that simulated collecting feedback from the user.

Results

Successes

Simplicity

The participants enjoyed the simplicity of the application.
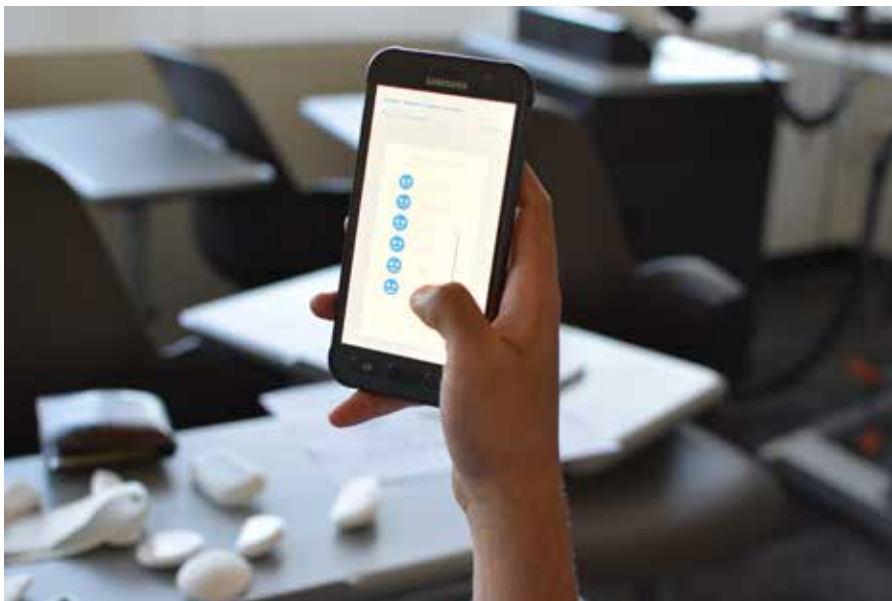
Tone

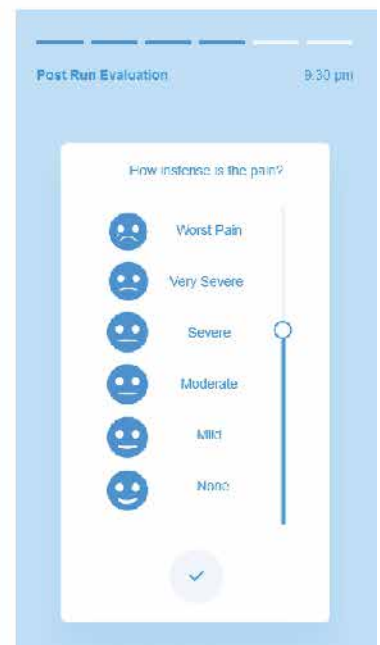The participants appreciated the friendly tone.

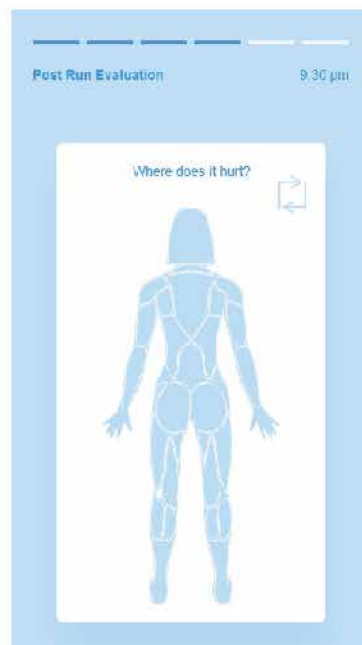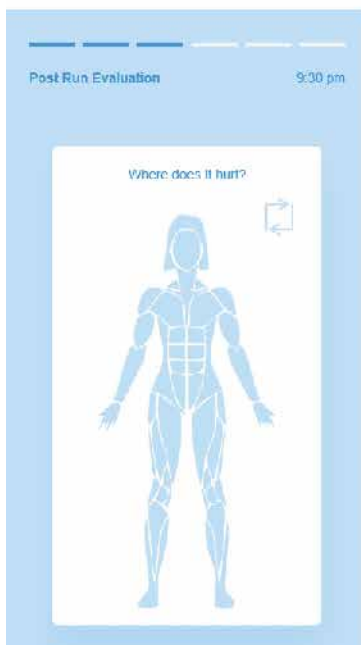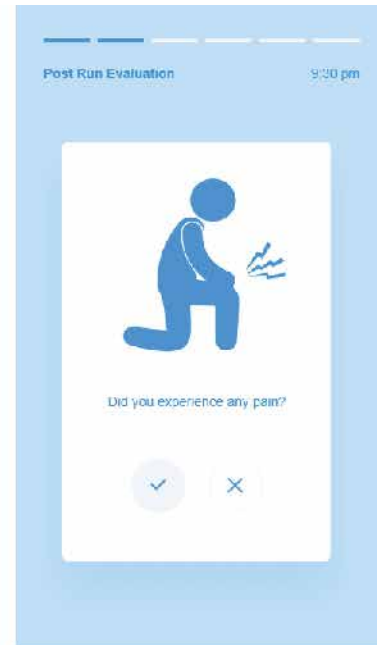### Improvement Areas

Give Feedback on Multiple Body Parts

Participants wanted the ability to give feedback on multiple body parts.

Even more Simple

The participants gave the feedback that further simplification would be even better.

User Study

Product Feedback

How the product should communicate with the user

Application

Gathering Information Stage

Give user feedback on how long it will take for the system to provide injury insight information.

This feedback should take no more than two weeks or ten runs to gather.

Sensor

Mid-Run Feedback

The user must have the option to use several different types of feedback including audio, haptic, and visual feedback.

The runner should not have to look at the sensor during the run. If nothing is wrong the runner should not even know it is there.

User Study

Final Question

Would this product positively augment your experience of running?

Total of 8 Participants

Response - Number of Participants
         Yes - 7
    Maybe - 1

Quotes from Participants

"It would make me more aware."

"I think it would hopefully empower me to be more cognizant of my running."

"I would be interested in understanding what is causing these really short of breath moments."

"It would have to deliver."

Totem

Sensor Design

Utilizing the feedback from the user study I created a appropriate design of the sensor

Form

Function

Internal System

Carry Case

Sensor Design

Final Form

Infusing user feedback into the final sensor form

Form Feedback

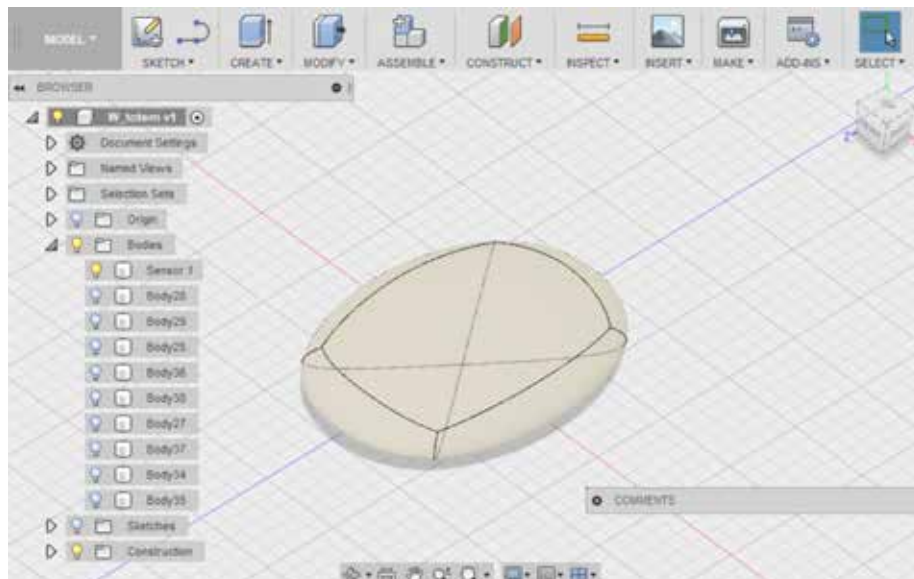The four sensors below were the shapes chosen by the participants in the user study.

Guiding Terms: Friendly, Low Profile, Lightwieght

Method
CAD Modelling in Fusion 360
I utilized the CAD 3D modelling platform, Fusion 360, to develop the final form of the sensor.
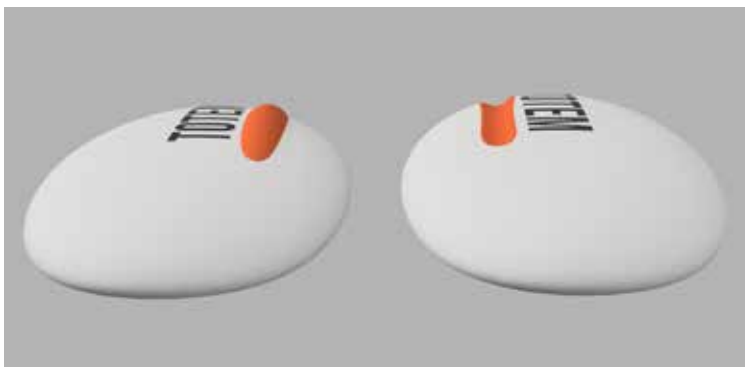
Sensor Interface
Raised Lettering on Surface - Tactile and Visual Interface

This system requires that six sensors be placed on the user's body. In order to prevent confusion I designed a system that you can both see and feel where the sensor should be placed on the body. There are two key indicators that allow the runner to know where the sensor should be placed, the size and the feel. The smaller sensors are mounted on the nape and shin and the larger sensors are mounted on the waist and thigh. The side, right or left, of the body the sensor should be placed is indicated by the bump or divet on the sensor. If the sensor has a bump it is mounted on the left side and if it has a divet it is mounted on the right.

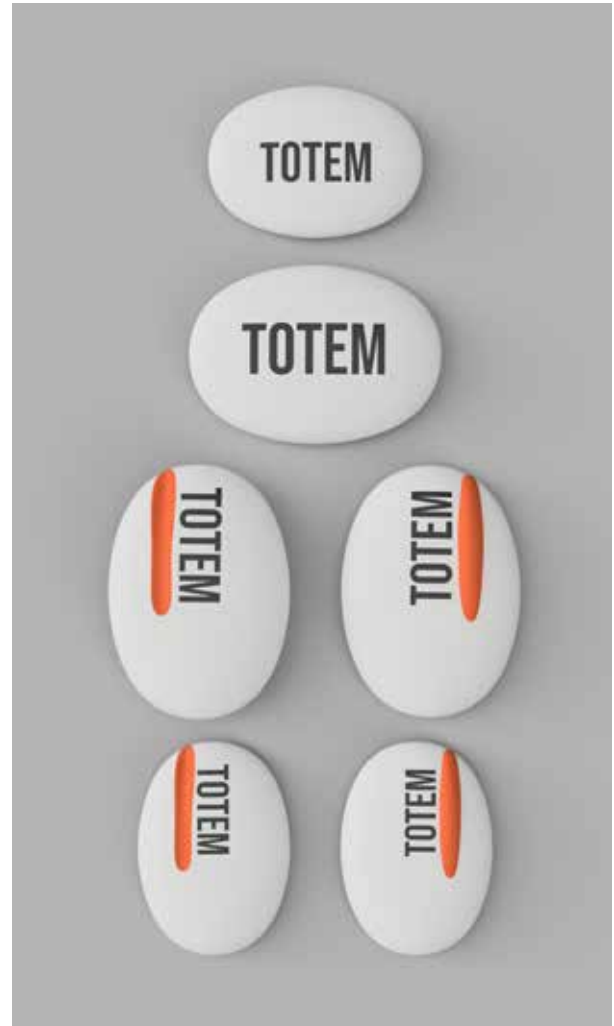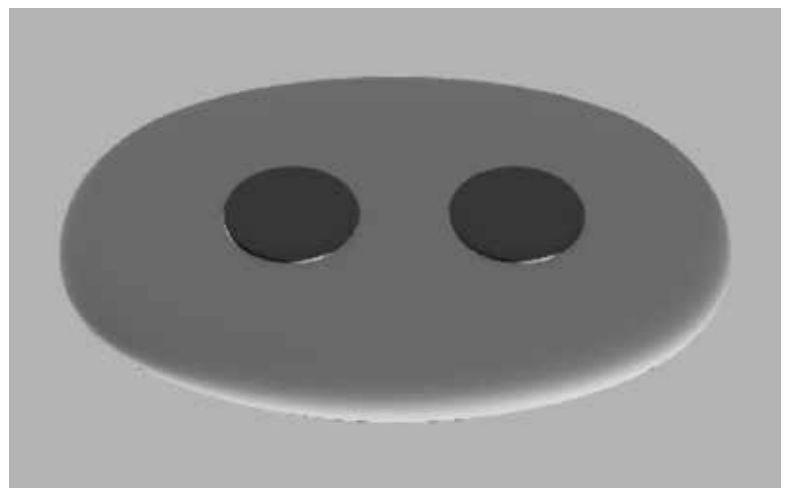**Bump**   **Divet**

Left   **Right**

Leads
Carry Case Interface

The backside of the sensor contains leads so that it can charge while it is in the carry case. The leads also act as a poka-yoke for any custom attachment devices that a third party might want to use on the device.

Sensor Design

Materials & Manufacturing Processes

Silicone Overmolding

Silicone, a synthetic polymer, was chosen as the outer material of the sensor due to its favorable material properties as well as the hand feel of the finished good. Silicone is soft and warm to the touch, making it feel friendly and approachable. From a durability perspective silicone has great impact resistance, chemical resistance, and water resistance (see the table below for more silicone performance properties).

  The process of overmolding ensures that the internal electrical components are sealed off from any harmful particulate that could corrode the electrical system. Overmolding also has low cycle times which is beneficial for mass production of the sensors.

Material Properties

The information in this section was cited from Material Connexion, Precision Silicone Parts by Silotech, MC 5951-01. (2018, Material ConneXion)

PERFORMANCE PROPERTIES

Acoustics Sound	Absorbing
Chemical Resistance	High
Colorfastness	High
Fire resistance	High
Impact Resistance	Good
Outdoor use	Yes
Reflectivity Light	Absorbing
Scratch resistance	High
Stain Resistance	High
Tear Resistance	Medium
Thermal Conductivity	Low
Usage Temperature	High
UV Resistance	High
Water Resistance	High
Wear Resistance	High

PHYSICAL PROPERTIES

Stiffness	Flexible, Rubbery
Structure	Closed
Surface/Texture	Glossy, Matte, Pattern, Texture
Transparency	Opaque, Translucent, Transparent
Surface Hardness	Soft

Images of Silicone Overmolded samples
(2018, Material ConneXion).

Sensor Design
Interaction Design
Infusing user feedback into the final sensor form

Carry Case

Pods automatically start recording once they are removed from the case.

① Charge carrry case via induction

② Remove Pods from carry case

Charges pods

③ Sensor Automatically Records data once removed from case

Pairs pods to Smartphone
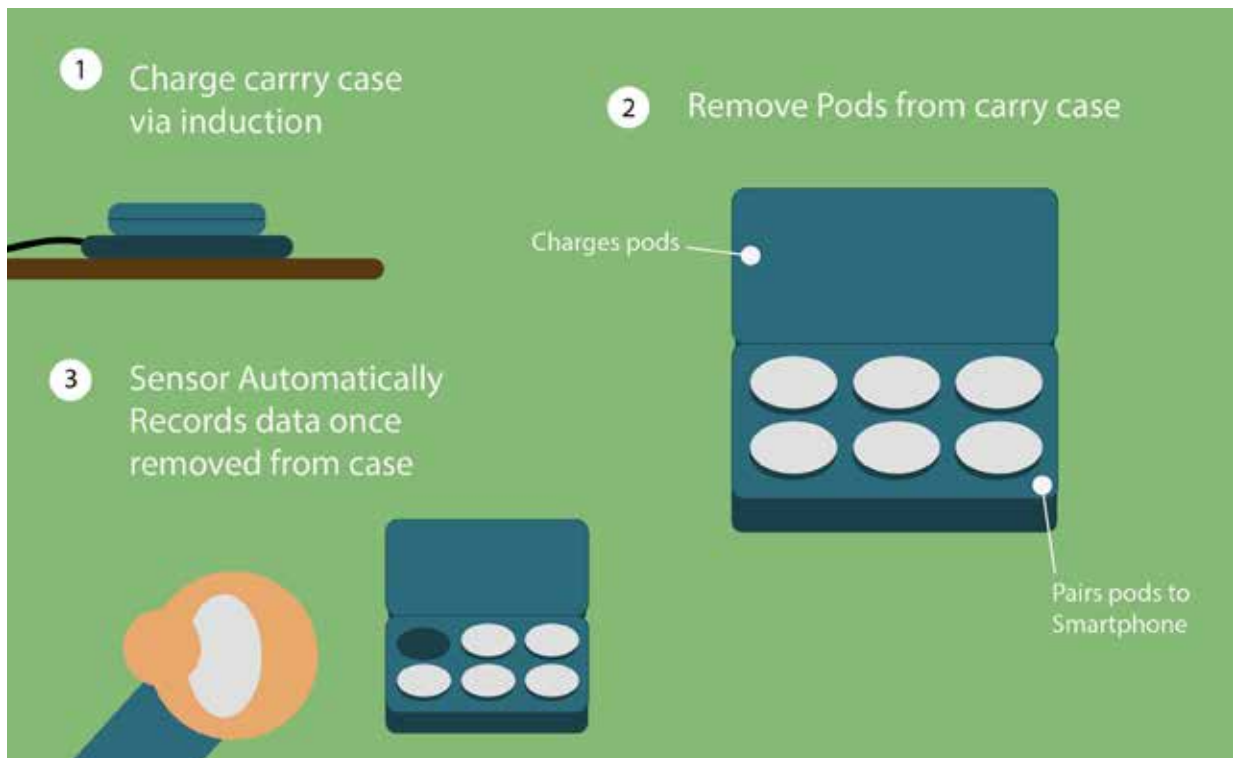
LEDs tell you the charge of the pods and the case.

When you open it the case the LEDs automatically shows you the charge of the sensors.

When you press the button the LEDs shows you how much charge the case has left.
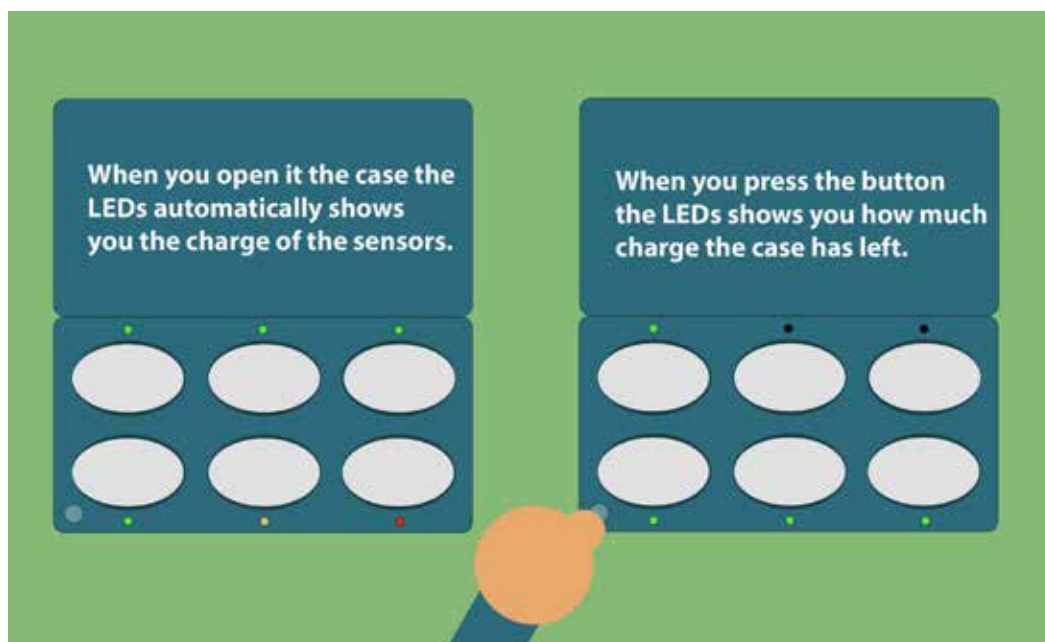
Sensor Feedback Mid-Run

Sensors warn you through vibration and auditory feedback if you are going hurt yourself.

Light Feature

Squeeze the sensor and it lights up. The sensor automatically start recording with or without the light on.
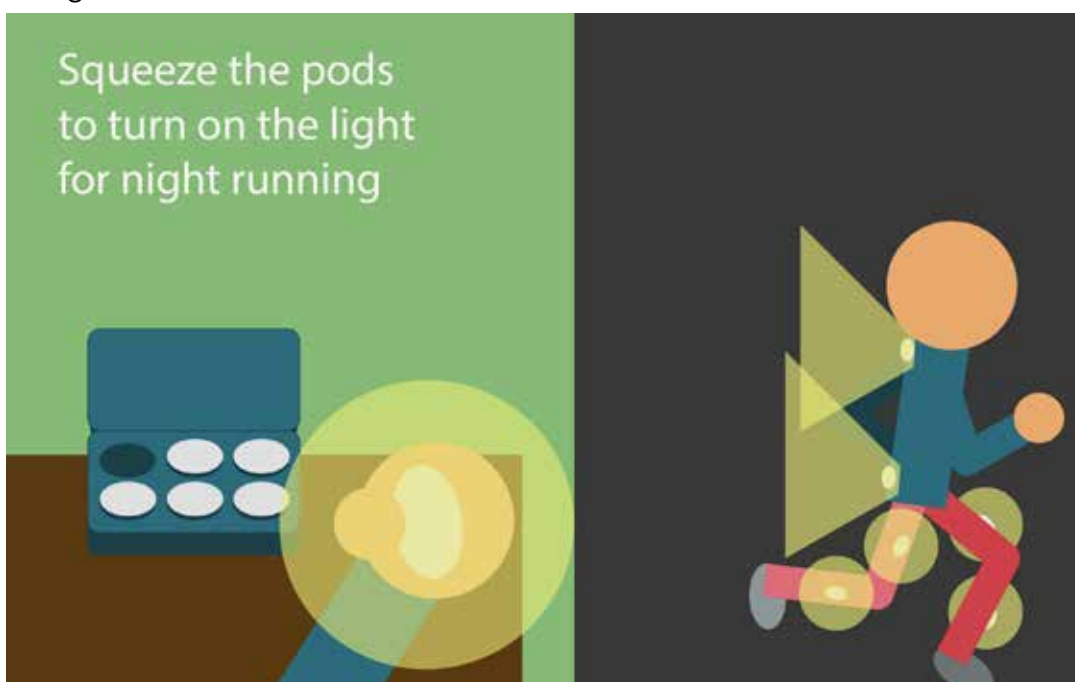
Sensor Design
Mounting Options

In order to attach electronics to the body you must attach the electronics through a medium like a garment to the body. Therefore, there are two elements that must be considered the garment and the way the sensor attaches to that garment

Garment to body
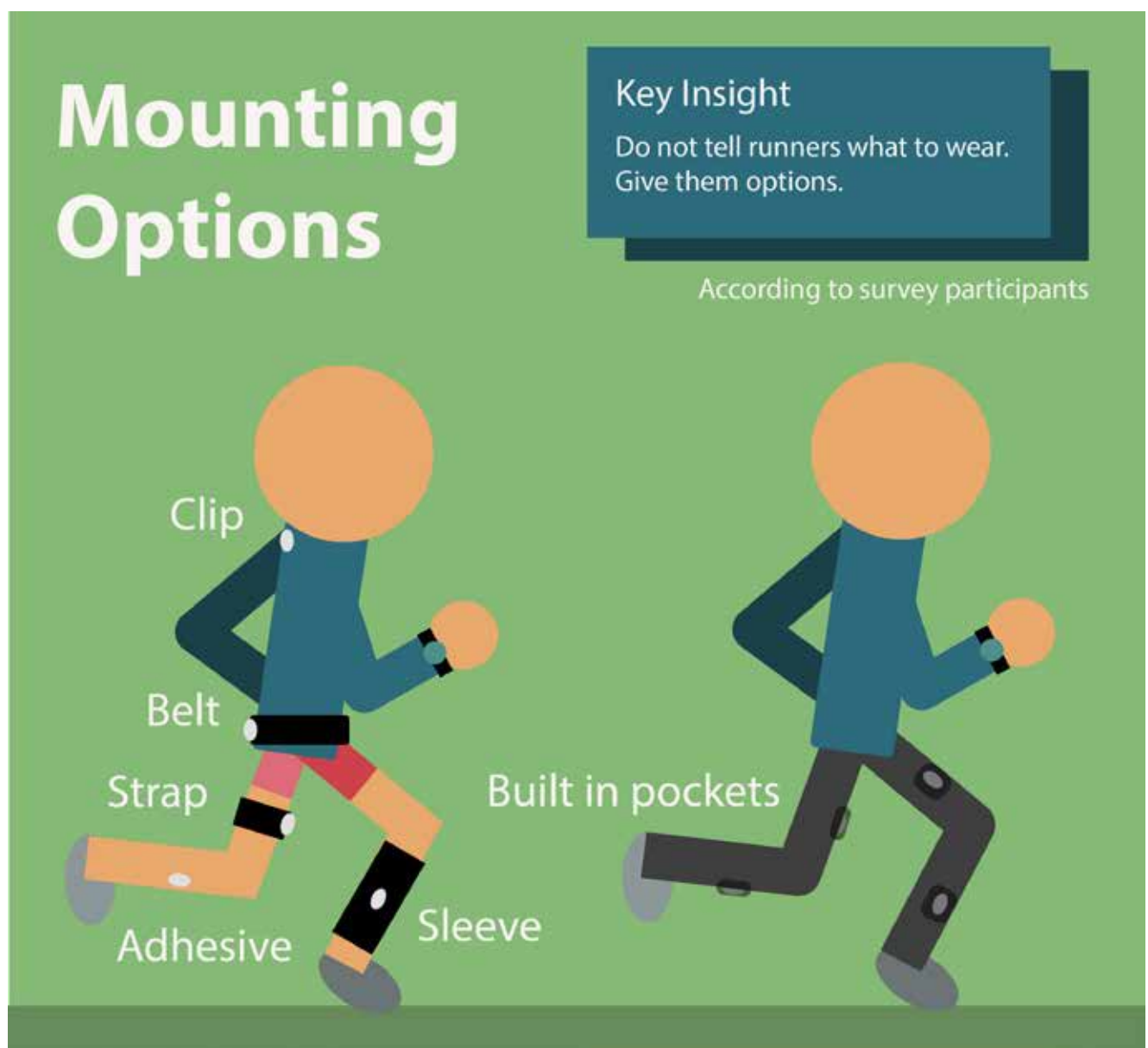
Attachment Options

Sensor to garment

Snaps

Magnets

Clip

Adhesive

Zipper

Elastic

Velcro

Sensor Design
Internal Components

All internal components were specced out from electronics manufacturers for size and function, cost was not considered. Certain components have a set volume and others have customized form factors. The components with a set volume, meaning the components that I was required to consider for the final form factor, include the storage, bluetooth, accelerometer, gyroscope, vibration motor and LEDs. The customizable components include the lithium ion battery, the circuit board, push button and contact leads. The Table below shows all of the components inside of the device.

Tech	Size	Function
Accelerometer		Core Data
Gyroscope	3 x 3 x 1mm	Core Data
Digital Motion Processor		Core Data
CircuitBoard	Thickness .1 to .3mm	Internal Connection
mini-SDCard	15 x 11 x 1mm	Storage
Bluetooth	3.5 x 3.5 x 1mm	Digital Communication
vibration	7 x 2.05mm	HCI
LED	10 (diameter) x 2 mm	HCI
Power	Customizable <.45mm thick	Battery

Technology embedded in the sensor, physical volume and function.

Internal Component Diagram
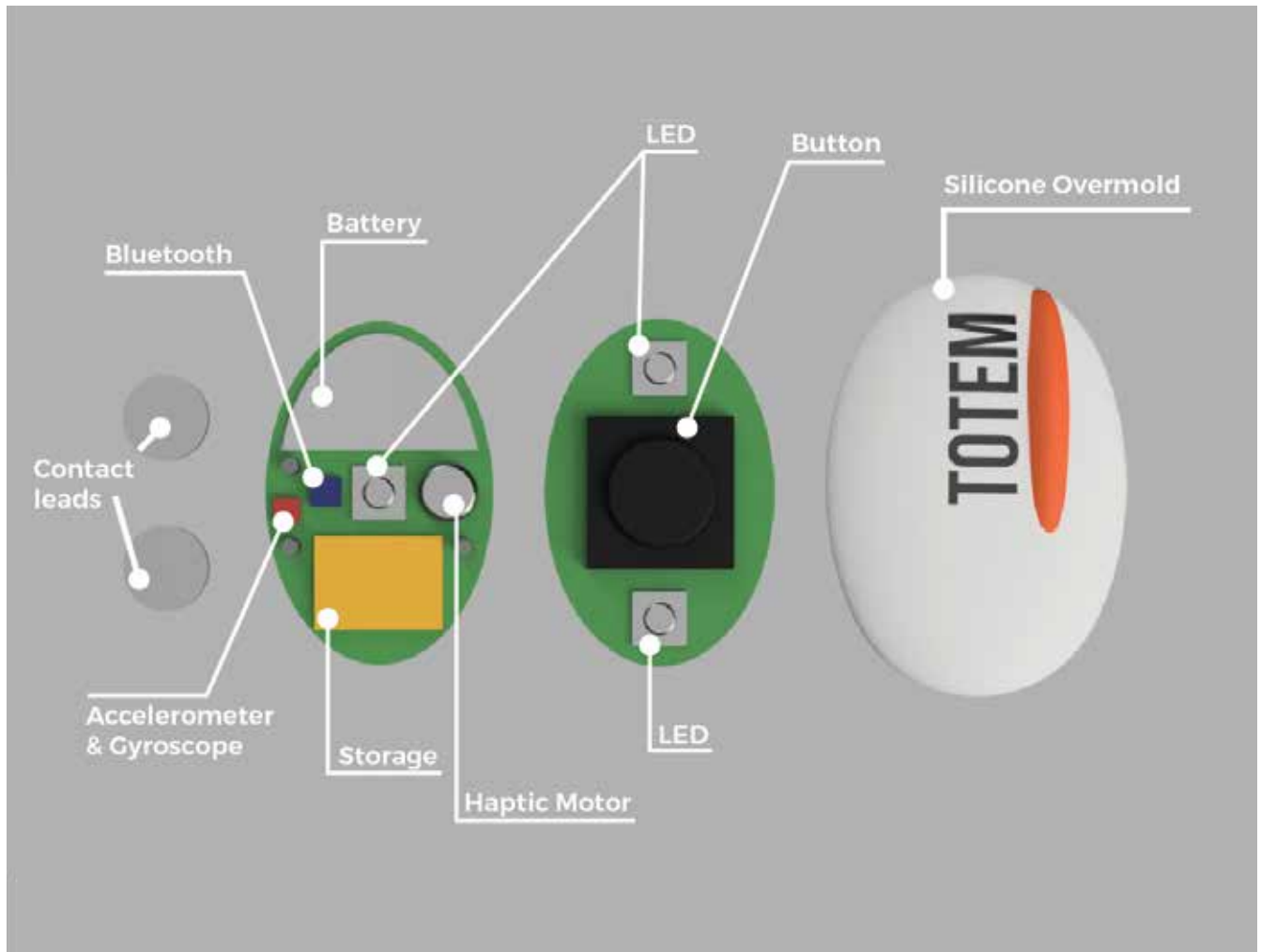
Totem

How the Design Meets Criteria

Wearability
Curved Edges

Universal Design
Size and bump indicate mounting

Washability
Silicone Overmold

Volume
Contains All Electronics

Proxemics
Less than .5 inches tall

Nape

Waist

Right Thigh

Left Thigh

Right Shin

Left Shin

Bump   **Divet**

Left   **Right**

TOTEM
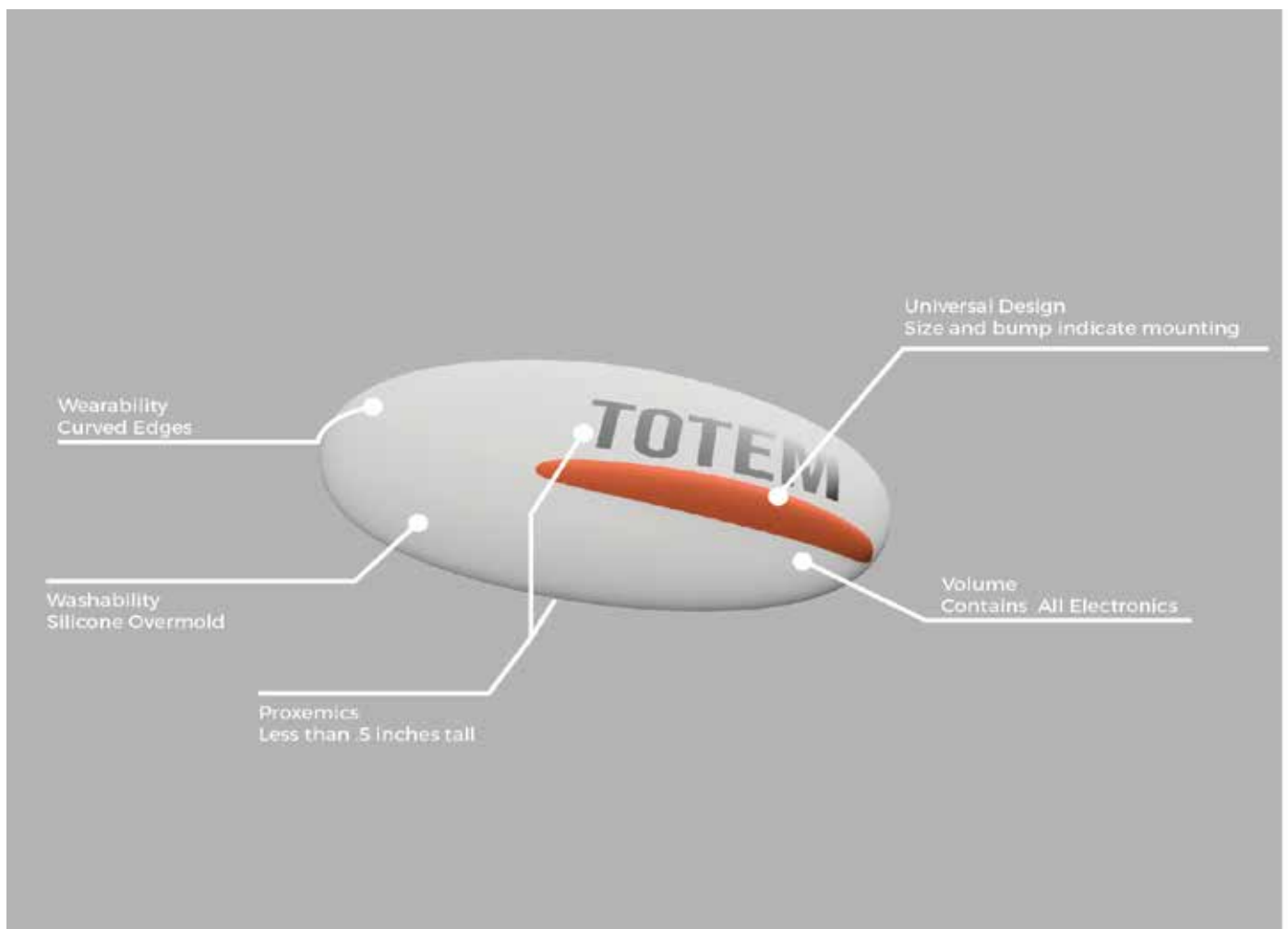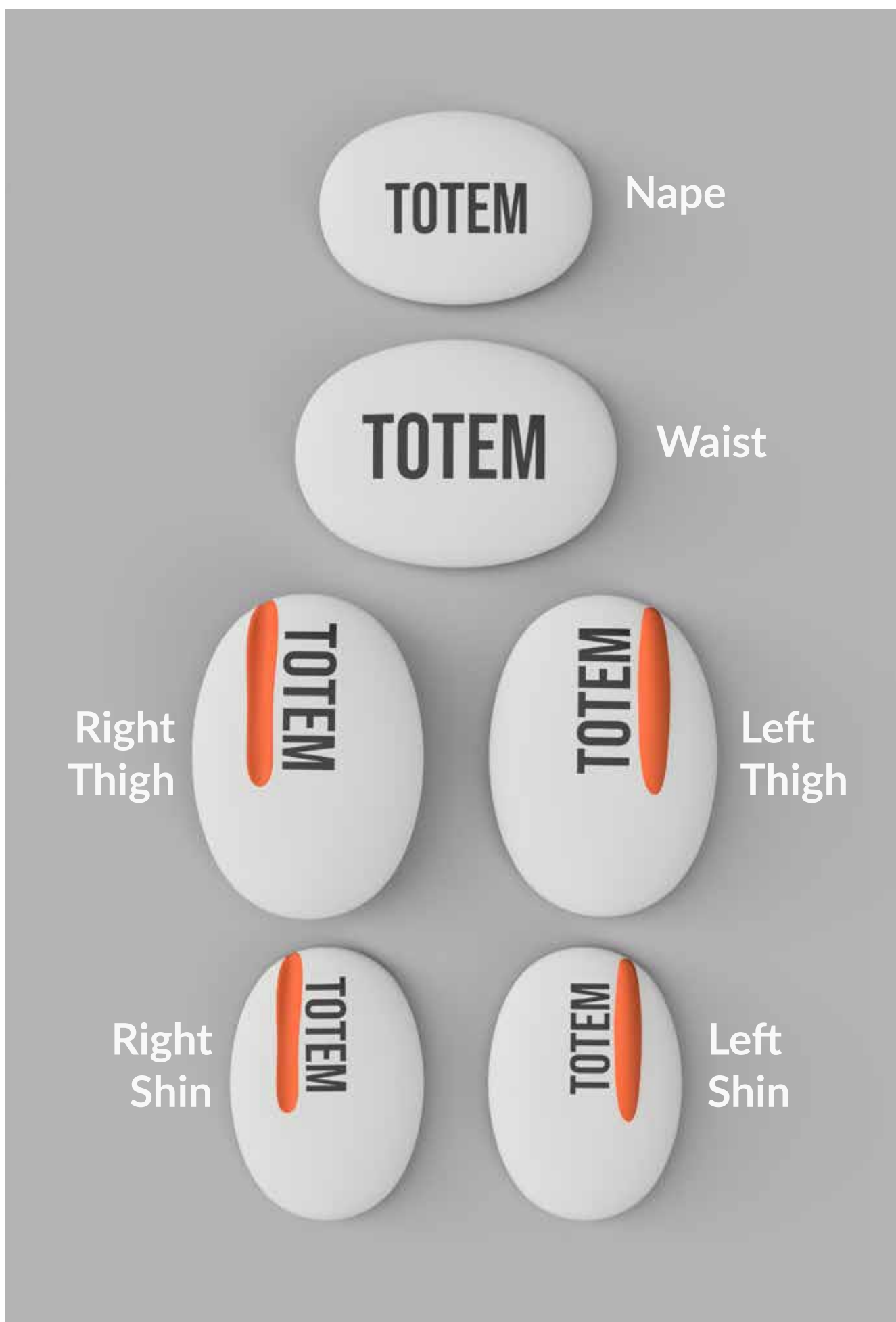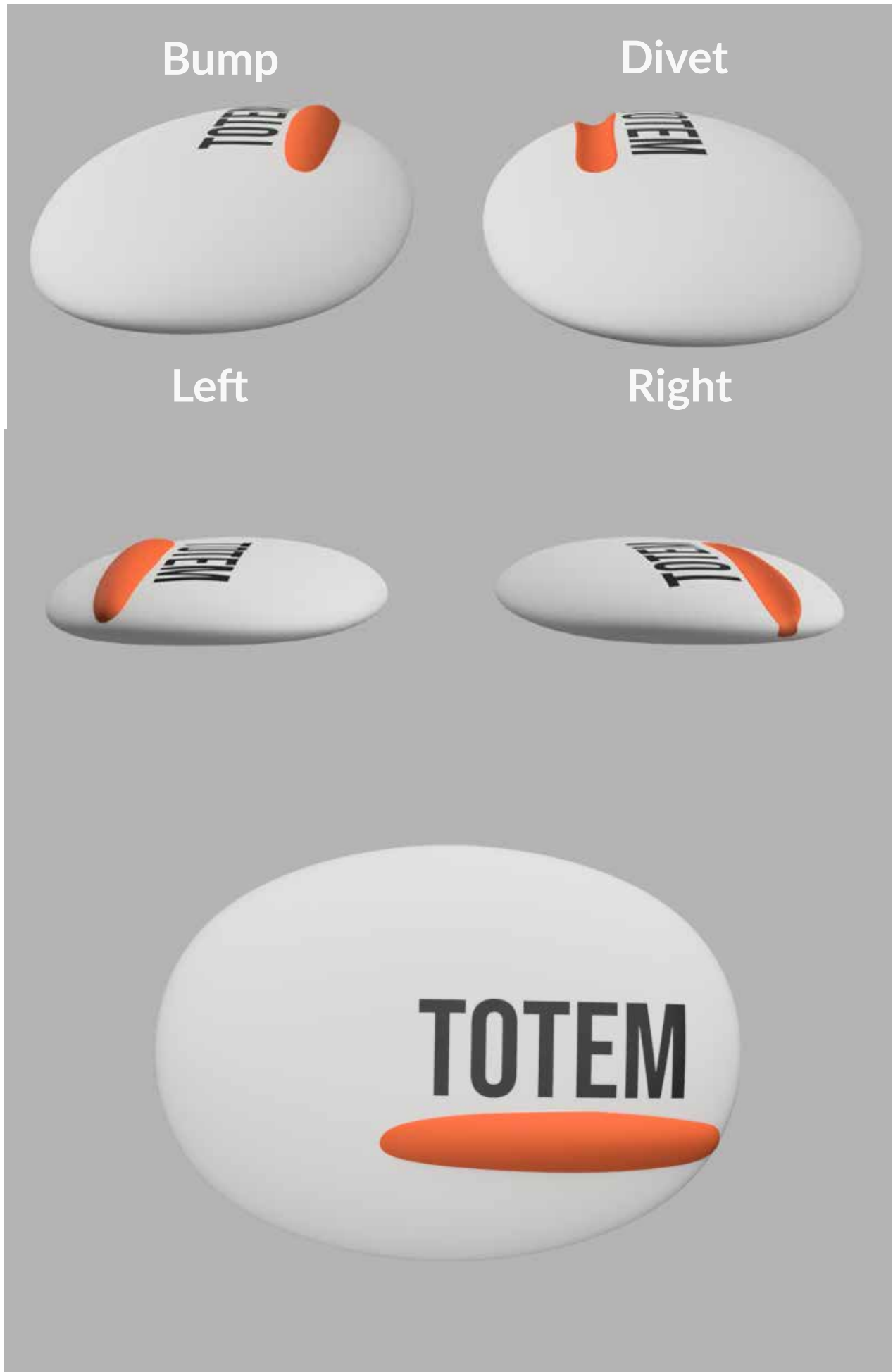
The Design In Context

Mounting the sensor

This final mounting method for the leg sensors are custom elastic pockets built into spandex pants. This choice was made due to a trend where runners are mounting cellphones to their thighs via custom elastic pockets built in to spandex pants. The fact that runners are already mounting their cell phones in this way means that it will be make this mounting method easier to accept.

Conclusion

This project has confirmed that the concept of Totem would positively augment the experience of running. The research in this project indicates that runners want to understand how and when they are going to hurt themselves and be warned before injury occurs. The final physical model created is one of many ways this product could be presented to users and whether this physical manifestation of the product is the most effective is still inconclusive. The greatest challenge moving forward is understanding the best method to mount these sensors on each body location. I recommend that further research be conducted in this area of study to understand the optimal method of electronics mounting onto a runner before, during, and after a run.

Experience of A Running Season
Before & After Totem

Body Status: No Injuries, Injury Developing, Injured
Season: Beginning, Middle, End

The concept would positively augment the experience of running.

Further Research Recommendations

A study evaluating all potential mounting options to understand the optimal mounting solution at each body location.

*It's not about what it is,
it's about what it can become.*

- Dr. Seuss

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Appendix A.1

Survey of Running Habits

You are being asked to be a volunteer in a research study.

Purpose:
The purpose of this study is gain an understanding of the habits of people who run and understand why they run. We expect to have 30 to 200 participants in the study.

Exclusion/Inclusion Criteria:
Participants in this survey must be at least of 18 years of age and no greater than 69 years of age.

Procedures:
You will be asked to fill out an online survey of 36 questions. This should take between 10 to 20 minutes. Your participation in this study is completely voluntary and you may choose to quit the survey at any point. No information will be recorded until you hit 'Submit' at the end of the survey. All responses to this survey are anonymous unless you explicitly choose to include your contact information. Upon completion of the survey you will be given an option to participate in a follow-up interview. If you choose to do so, please provide your contact information at the end of the survey.

Risks or Discomforts:
The risks involved are no greater than those involved in daily activities such as using your computer or phone.

Benefits: You are not likely to benefit in any way from participating in this survey. We hope that what we learn will help future research studies that aim to improve the design of products for runners.

Compensation to You:
There is no compensation for participation in this survey.

Confidentiality:
Your responses to the online survey are being recorded via Google Forms on a secure https server. No personally identifiable information will be recorded unless you voluntarily choose to enter it.

Your privacy will be protected to the extent required by law. Your name and any other fact that might point to you will not appear when results of this study are presented or published. The results of this survey will only contain group mean results and will contain no personal information. To make sure that this research is being carried out in the proper way, the Georgia Institute of Technology IRB may review study records.

Costs to You:
There are no costs to you, other than your time, for being in this study.

In Case of Injury/Harm:
If you are injured as a result of being in this study, please contact Kevin D. Shankwiler, Principle Investigator at telephone (404) 229-5052 or Natalie Salk, Co- Investigator at (401) 742-4763. Neither the Principal Investigator nor Georgia Institute of Technology has made any provision for payment of costs associated with any injury resulting from participation in this study.

Participant Rights:
•   Your participation in this study is voluntary. You do not have to be in this study if you don't want to be.
•   You have the right to change your mind and leave the study at any time without giving any reason and without penalty.
•   Any new information that may make you change your mind about being in this study will be given to you.
•   You may choose to download or print a copy of this consent form to keep.
•   You do not waive any of your legal rights by completing the survey.

Questions about the Study:
If you have any questions about the study, you may contact the Principle Investigator, Kevin D. Shankwiler at (404) 229-5052 or kshankwiler@gatech.edu (or) Co-Investigator, Natalie Salk at (401) 742-4763 or nsalk3@gatech.edu.

Questions about Your Rights as a Research Participant:
If you have any questions about your rights as a research participant, you may contact Ms. Melanie Clark, Georgia Institute of Technology, Office of Research Integrity Assurance, at (404) 894-6942

By completing the online survey, you indicate your consent to be in the study.

* Required

Demographics

1. **What is your Gender?**
   Mark only one oval.

   ◯ Female

   ◯ Male

   ◯ Prefer not to say

   ◯ Other: _____

2. **What is your country of origin?**

   _____

3. **How would you describe the cultural group you belong to?**

   _____

4. **What is your age?** *
Mark only one oval.

◯	Less than 18	*After the last question in this section, stop filling out this form.*
◯	18	
◯	19	
◯	20	
◯	21	
◯	22	
◯	23	
◯	24	
◯	25	
◯	26	
◯	27	
◯	28	
◯	29	
◯	30	
◯	31	
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◯	51	
◯	52	
◯	53	
◯	54	

○ 55
○ 56
○ 57
○ 58
○ 59
○ 60
○ 61
○ 62
○ 63
○ 64
○ 65
○ 66
○ 67
○ 68
○ 69
○ Greater than 69   *After the last question in this section, stop filling out this form.*

5. **How would you describe the area you live in?**
   Check all that apply.

   ☐ Urban

   ☐ Suburban

   ☐ Rural

   ☐ Other: _____

6. **Which city or town do you live in? (example format: Atlanta, GA)**

   _____

Do you run?

7. **Do you run?** *
   Mark only one oval.

   ○ Yes   *Skip to question 8.*

   ○ No   *Skip to question 37.*

   ○ Other: _____   *Skip to question 8.*

Runner Survey

8. **How did you start running?**

_____

_____

_____

_____

_____

9. **What keeps you running?**

_____

_____

_____

_____

_____

10. **Is running your primary sport?**
    Mark only one oval.

    ( ) Yes

    ( ) No

    ( ) Other: _____

11. **Why do you run? (examples: To Run faster, improve fitness, relax, let off steam)**

_____

_____

_____

_____

_____

12. **What other sports or athletic activities do you do?**

_____

13. **Are you involved in a running community?**
    Mark only one oval.

    ( ) Yes

    ( ) No

    ( ) Other: _____

14. **If you are part of a community how does it impact your running experience?**

_____

_____

_____

_____

_____

15. **If you are in a running community ow would you describe it? (Are they online, do you meet in person? Are you in a club?)**

_____

_____

_____

_____

_____

16. **What type of terrain do you run on?**
Check all that apply.

☐ Road

☐ Off Road Trail

☐ Track

☐ Treadmill

☐ Elliptical

☐ Paved Path

☐ Other: _____

17. **What kind of running events do you participate in?**
Check all that apply.

☐ 5K

☐ Half Marathon

☐ Marathon

☐ Triathalon

☐ Track & Field

☐ Obstacle Races (example: Tough Mudder)

☐ Other: _____

18. What kind of sports events do you participate in?

Check all that apply.

☐ Soccer

☐ Tennis

☐ Basketball

☐ Football

☐ Baseball

☐ Hockey

☐ Swimming

☐ Other: _____

19. Why do you participate in these events?
(running and other sports events)

_____

20. How long are your regular runs? (Answer in Miles)

Mark only one oval.

◯ Less than 1

◯ 1

◯ 2

◯ 3

◯ 4

◯ 5

◯ 6

◯ 7

◯ 8

◯ 9

◯ 10

◯ Greater than 10

21. How many miles do you run in a week? (Answer in miles)

Mark only one oval.

◯ Less than 5

◯ 5 to 15

◯ 15 to 25

◯ 25 to 35

◯ 35 to 45

◯ 45 to 55

◯ 55 to 65

◯ 65 to 75

◯ Greater than 75

22. **What time of day do you run?**
Check all that apply.

☐ 12am to 4am

☐ 4am to 8am

☐ 8am to 12pm

☐ 12pm to 4pm

☐ 4pm to 8pm

☐ 8pm to 12am

23. **Where do you get ready to go on a run?**
Check all that apply.

☐ Home

☐ Work

☐ Gym

☐ School

☐ In my car

☐ Other: _____

24. **What do you do right after you finish a run?**

_____

_____

_____

_____

_____

25. **Do your running habits change throughout the year? How so?**

_____

_____

_____

_____

_____

26. **Do your running habits change due to changes in the weather? How so?**

_____

_____

_____

_____

_____

27. **Does anything ever limit your ability or desire to run? Please, tell me about it.**

_____

_____

_____

_____

_____

28. **What gear can you not run without? - This can be an emotional or physical. For example: "I just can not run with my music" or "I can not run without my shoes."**

_____

_____

_____

_____

_____

29. **What is your favorite piece of running gear? Why?**

_____

_____

_____

_____

_____

30. **Do you use technology when you run? (examples:cell phone, fitness trackers, step trackers)**
    Mark only one oval.

    ◯ Yes

    ◯ No

    ◯ Sometimes

    ◯ Other: _____

31. **What kind of technology do you use? Why?**

_____

_____

_____

_____

_____

32. **What self quantifying information do you monitor? Why? (examples of self- quantifying information is, heart rate, steps, etc...)**

147

_____

_____

_____

_____

_____

33. **Do you use smart phone applications? Which one do you use? Why?**

_____

_____

_____

_____

_____

34. **Do you have any eating habits related to running? What are they?**

_____

_____

_____

_____

_____

35. **Please tell me about the worst run of your life.**

_____

_____

_____

_____

_____

36. **Please tell me about the best run of your life.**

_____

_____

_____

_____

_____

Skip to question 40.

Non-Runner Survey

37. **Explain why you do not run.**

_____

_____

_____

_____

_____

38. **Have you tried running? What happened when you tried?**

_____

_____

_____

_____

_____

39. **What types of exercise (examples: sports, classes, lifting at the gym) do you participate in? Why?**

_____

_____

_____

_____

_____

Skip to question 40.

Follow Up

40. **Phase two involves one on one interviews to gain further insights. All answers will remain confidential. If you would be willing to participate in a follow up interview please provide your email address below. If you do not wish to participate please press submit.**

_____

Skip to "Thank you for your participation!."

Thank you for your participation!

Thank you for your participation in this study! If you have any questions or if you are interested about the results of this study, you may contact the Principle Investigator, Kevin D. Shankwiler at (404) 229-5052 or kshankwiler@gatech.edu (or) Co-Investigator, Natalie Salk at (401) 742-4763 or nsalk3@gatech.edu.

Powered by

Google Forms

Appendix A.2

Social Media Post

Running Habits
Recruitment Social-Media Post - Draft

You are being contacted to participate in a research survey about running habits. My name is Natalie Salk and I am a Master of Industrial Design student at Georgia Institute of Technology. I am currently working my graduate thesis which is focused on understanding how the running experience may be impacted through the integration of interactive technology.

As a part of my research, I am reaching out to runners and non-runners to participate in an online survey. The survey should take no more than 30 minutes and is available online at http://goo.gl/forms/examplelink.

Please feel free to write back to me if you have any questions. Thank you for your time.

Regards,

Natalie Salk
B.S. Mechanical Engineering
Master of Industrial Design
Georgia Institute of Technology

Appendix B.1
Participant Interview Questions

Semi-structured Interview Outline
The Experience of Running
Time: 1 hour long

Introductions

What is your age?
How long have you been running?
Do you consider yourself a runner? When did you start considering yourself as a runner?
What type of runner are you? [Probe: Elite, Beginner, Casual, Semi - Causal]
How long are your normal runs?
What type of terrain do you normally run on? [Probe: When its hot, when its cold]

The Experience

Please Describe your typical run from beginning to end.

What do you do before you run?
What do you do while you are running?
What do you do after you run?

How do you recover from run? [This is specifically meant for tempo or more difficult runs]
How long does recovery last for you?

How do you feel over the course of a normal run?
[Use paper here have them draw a graph of how they feel before during after a run]

When do you decide you are going to go on a run?
Does running affect any of your habits? [Probe for eating, sleeping, self care, social habits]
How long do you feel the effect of running?
How often do you think about running?

Pain Points
What is the most annoying part of running? [Probe for: preparation, running, pain, self care post run]
Do you find anything frustrating about running? [Probe for: slowing down with age, injury, runner's high, hitting the wall, poop]
Have you ever hit the wall? Tell me about it.
Do you have issues storing personal effects?

General Probes: Injury, poop, extreme weather, poor preparation, missed goals, emotional distress, sickness

Runners High
Have you ever had the runner's high? What does it feel like to you?
When do you get the runner's high?
What are the things that make you forget you are running?

Motivation
Why do you run? [Probe: Physical/Mental Health]
What are your goals? [Probe: Runner's high, hit stat targets, finish races]

Mental Health
Does running have an effect on your mental state? (Probe for: running's relationship to mental well-being).

Physical Health
Have you ever been injured?
How do you recover from injury?
What is your relationship to pain?

Community
Are you part of a running community?
What are the values of your running community? [Probe: Inclusivity]
Do you use social media in conjunction with running? Why?
Does family play a part in your running experience?

Racing
How do you prepare for races?
Tell me about your best race ever.
Tell me about your worst race ever.
How are normal runs and races different?
How do you choose which races to participate in?

Technology
Do you use technology when you run? Why? Can you show it to me?
What information do you track? Why?
Probes: Routes, pace, distance, heart rate, steps time, elevation, calories, weight, VO2
What information do you not have today that you wish you had?

Gear
What gear do you use when you run? Can you show it to me?
Do you have to take care of your gear in any special way?
What would be your dream gear?

Cross Training

Do you balance other sports with your running routine?
What sports? Tell me about it.

Expression
Are you attached to any specific pieces of running gear?
Do you use your gear as a form of expression?
Do you have any "signature" pieces of running gear that represents you? If yes what is it and why?

Environment
Does nature play a role in your running experience?
Do you like running in the rain? Why or why not?

Future
If you were to have the ultimate piece of running gear what would it be?
What do you expect your relationship with running will be like in the next 10 years?

Follow Up
Would you be willing to participate in further research? If so, please sign up on google doc.

Expert Interviews

Trends, technology and every day design in the athletic and outdoor industries.

It was critical to my project that I understood the landscape of the Athletic and Outdoor Industries before I formulated my research question. I travelled for three weeks around the United States conducting expert interviews with designers in five different companies, Adidas, Nike, Reebok, The North Face, and REI. I went to gain perspective on what it is like to work in these companies, to learn what these companies are actually doing, and to gain an in depth understanding of the trends and technology in the Athletics and Outdoor Industries.

The Athletics and Outdoor Industries sell the same products (e.g. shoes, jackets, pants, etc...) to different targeted demographic groups. The two industries function in different ways with different long term strategies. The Outdoor companies and their design teams seemed to be more focused on the seasonal consumer, retail and ethnography. The Athletics companies were focused on seasonal marketing and ethnography but they also have a heavy focus in technology and in house manufacturing techniques.

The expert interviews I conducted have been redacted from this paper in order to uphold Non-Disclosure Agreements that the author signed to preserve the privacy of the individuals as well as the corporations involved. The intent of this research was to understand overall trends which will be discussed in the next section.

Industry Expert Interview Guide

What trends do you see in the industry?

What emerging technology do you see influencing the future of sports and technology?

What problems do you run into?

What are big problems that your team is trying to solve (you don't have to answer this if it's proprietary info)?

Appendix C.1
Product Evaluation/User Study

Task List

Device Task list

1. Remove device from carry case
2. Turn device on
3. Attach device to mount
4. Take device off mount
5. Turn device off
6. Place device into carry case

Interface Task list

You will be asked to enter three conditions into the application.

1. Enter that you have experienced the runner's high
2. Enter that you have experienced pain on the front lateral(outside) side of your right knee (see Figure 1 below)
3. Enter the pain was moderate

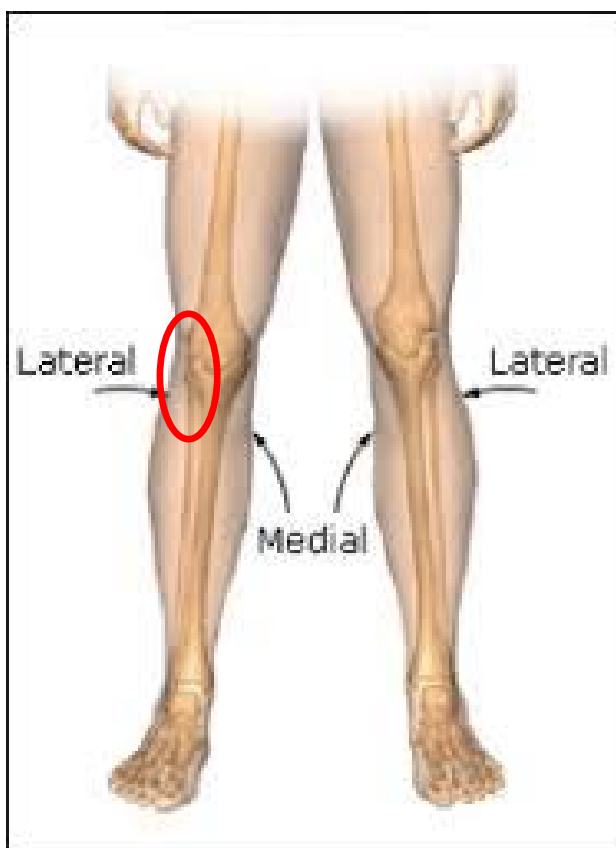Figure 1. Front lateral side of knee

Figure 1

Example Script for Running Buddy Prototype and App Interface Inspection and Open Interview

INTRO

This study is designed to evaluate a physical prototype and an interface related to improving the experience of running. For both the physical prototype and interface the user will be asked to complete a series of tasks. After the tasks are complete the researcher will conduct an interview with the participant. There will be no personal information collected outside of audio and visual recording of the study.

Description of the device prototype ("running buddy"):

The prototype is a small light electronic device that can fit into the palm of your hand. The device is made of a plastic like material and it does **NOT** have any exposed electronics. The goal of the prototype is to simulate the experience of using the device, through a "Wizard of Oz" method. For example, if the user presses a button a light will turn on. This running buddy device is a "looks – like" model meaning it gives the appearance like it is working but it is only a simulation of the experience, it is not a functional model. See image below

Internal Components:

The internal components will not be accessible by the subject. There will be minimal electronics inside of the device which will allow for simple control of led lights. The voltage inside of the device will not surpass 5 volts and the amperage flowing through will only be enough to power simple LED lights. The battery will be a lithium polymer battery which is standard in creating small electronic prototypes.

If you need a reference for the size it will be similar proportions to this object in figure 1 below.
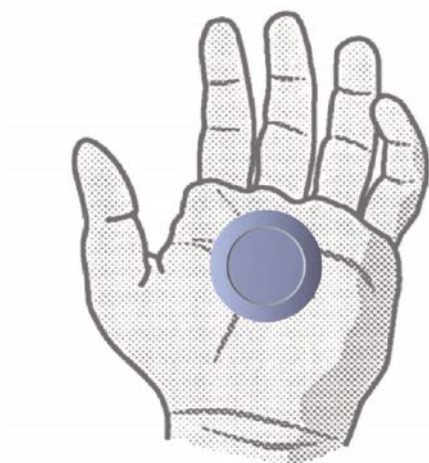

Figure 1. Sketch of Running Buddy

Description of the Interface:
The interface will be simulated in the Adobe XD application run on a Samsung 7 Active cellphone. The researcher will open the app and hand the phone to the user. The user will first be instructed to complete a task (listed below) and then once the task is complete they will be able to inspect the application further.

Figure 2. Samsung Galaxy S7 Active   **Figure 3. Adobe XD logo**

Procedure Overview

There will be no personal information collected outside of audio and visual recording of the study.

Part 0
Before Inspection
1) Participant will be greeted
2) Participant will be presented with consent forms (see consent for attached to this protocol)
   a. Consent form
   b. Model Release form
      i. If the participant does not consent to being recorded, the study will still proceed without any recording (other than note-taking).
3) Participant will review forms and if they accept the conditions and sign the form the participant will continue to part 1 of the user study

Part 1
Inspection of Running Buddy Prototype

If the Model Release Form has been obtained by the researchers, the participant will be audio and visually recorded.

In the unlikely case the participant cannot complete a task after 3 minutes the researcher will assist the participant.

1. Study participants will be verbally introduced to the product (see script below)
   a. "This product is designed to collect movement information from the user so that it can be processed and later give you feedback on how you can improve your running experience".
2. Participants will be provided with a document that describes the tasks they will asked to complete. The document will provide instruction but will not show how to complete the task. This design is intentional, it will allow the researchers to understand if the design cues and affordances on the running buddy device itself are enough for the user to understand the device.
3. Study participants will receive instructions for their task
   a. **Task 1**: Remove the running buddy device from its carry case
      i. The researcher will ask the participant please remove the device from the carry case
      ii. The participant will remove the device from the case
   b. **Task 2:** Turn on the running buddy device
      i. The researcher will say "please turn on the device"
      ii. The participant will turn the device on the device
   c. **Task 3:** Insert onto mount
      i. The researcher will say "please insert the device onto the mount."
      ii. The participant will attach the device onto the mount
   d. **Task 4:** Remove the running buddy device from the mount
      i. The researcher will say "please remove the device from the mount."
      ii. The participant will remove the device from the mount
   e. **Task 5:** Turn the running buddy device off
      i. The researcher will say "please turn off the device."
      ii. The participant will turn the device off
   f. **Task 6**: Place running buddy device into carry case
      i. The researcher will say "please place the device into the carry case"
      ii. The participant will place device into the carry case

Part 2
Interaction with Interface

If consent has been obtained by the researchers, the participant will be audio and visually recorded.

In the unlikely case the participant cannot complete a task after 3 minutes the researcher will assist the participant.

1. Study participants will be briefly verbally introduced to the on-phone app interface (see script below)

Areas of feedback to probe for:

Running Buddy Prototype:
- What elements of the design are successful?
- What element of the design would you improve?
- Human factors: How does the device fit in/with your hand?
- What do you think of the aesthetics of the device?
- What do you think of the function of the device?
- Which areas of the design do you enjoy most?
- Which areas of the design did you enjoy least?

App Interface:
- How did you feel about the process of interaction with the app?
- What elements of the design are successful?
- What element of the design would you improve?
- What do you think of the aesthetics of the interface?
- What do you think of the function of the interface?
- Which areas of the design do you enjoy most?
- Which areas of the design did you enjoy least?

Overall:
- Do you think this product would improve your running experience?
  - Yes
  - No
  - Maybe

Finish:
- Thank the participant for their time, and offer to provide the participants with a copy (digital) of the project when complete.

  a. "This interface is designed to collect information from the user so that it can be processed and later give you feedback on how you can improve your running experience".

2. Participants will be provided with a document that describes the tasks they will asked to complete. The document will provide instruction but will not show how to complete the task. This design is intentional, it will allow the researchers to understand it the design cues and affordances on the app interface itself are enough for the user to understand the interface. This task will **not** collect any personal information, the participant will be given predetermined inputs that will be provided in the task document. (see attached document)

3. Study participant will be handed a cell phone with the app interface prototype at the ready.

4. Study participants will follow the tasks laid out on the sheet. They are as follows:

  a. **Task 1**: Submit that you have achieved the runner's high
    i. The subject will tap the screen until they have submitted they have experienced the runner's high.
      1. For reference, the "runner's high" is a colloquial term used by runners to describe a zen-like state experienced during and after runs.

  b. **Task 2:** Enter a pain on the lateral side of their right knee (Note: this is not real pain, but rather a fictitious condition set by the researcher).
    i. The participant will tap through the interface until they have successfully entered a condition of feeling pain on the lateral side of their right knee
      1. In the case that the participant does not know what the lateral side of the right knee is a picture on the task explainer document will contain a picture indicating where the lateral side of the right knee is.

  c. **Task 3:** Enter the pain was moderate
    i. The participant will tap through the prototype until they enter the moderate level of pain

Questions After Inspection & Interaction

Study participants will be asked a series of follow-up questions to gain feedback the prototype and interface.

These questions are designed to get a broad range of feedback from the user. They are intentionally broad and ambiguous. Specific questions may create a framing effect and bias the participant.