



knex

Our Team



Idrys Rudnick Cohen
Industrial design



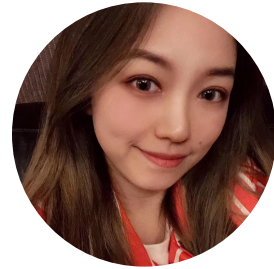
Hoi Man Mak
Graphic design



Luke Tan
Service Design



Xuan Grace
Interactive design



Danlei Xiang
UX design



“

*It sucks, but it is something I have been learning to deal with. If I have **sharp pain** I need to go to the hospital. If there is **soreness**, I can't lift my leg up, and that's what's hard.*

”



Our Expert on **Patellar Tendinitis**

Emma is a 21 year old designer currently pursuing a degree in Industrial Design. She is an **ambitious decisive athletic** person with **a lot of energy** and **passion** for design.

She grew up with ADD as a kid and participated in a lot of sports to control it, in lieu of medication that she had weird reactions to.

She broke her leg in high school but did not get it checked until college, causing her to develop Patellar Tendonitis and tear an LCL.

Secondary Research



Patellar Tendinitis

Pain between kneecap and where the tendon attaches to shinbone



Physical activity. Running and jumping. Sudden increases in how hard or how often one engages in the activity bring stress to the tendon.

Tight leg muscles. Tight thigh muscles (quadriceps) and hamstrings affect the back of one's thigh, can increase strain on the patellar tendon.

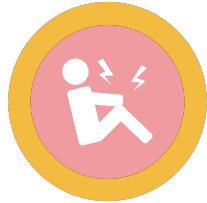
Muscular imbalance. Some muscles are much stronger than others. The stronger muscles can pull harder on one's patellar tendon, causing unevenness, which can cause tendinitis.

Symptoms of Patellar Tendinitis



Anterior Knee Pain

Anterior knee pain over the patella tendon



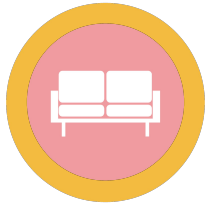
Tenderness

Localized tenderness over the patella tendon



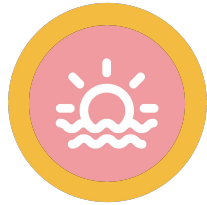
Stepping Leg Motions

Knee pain gets worse when running, jumping, or walking on hilly surfaces



Prolonged Sitting

Knee pain gets worse when sitting for too long



Morning Stiffness

The tendon often feels very stiff and sore first thing in the morning



Swelling

Knee swells up with inflammation and can burst if not taken care of



up to a **22%** occurrence
rate in athletes

20% in sports that require jumps

25% - 32 % in basketball

30% - 51% in volleyball

Heals in 3-6 weeks if treated properly

Chronic patellar tendinopathy manifests after 6 weeks to 3 months
as degenerative change and occurs in the tendon

Occurs more frequently in skeletally mature adolescents or adults,
ranging from 16-40 years

“

...my knee was **completely swollen**. I was trying to walk up the stairs, but I couldn't walk up the stairs fully by myself...sometimes I'll sit on the couch and I won't realize that I **won't be able to walk myself** all the way up...

”



Primary Research





First Interview

day: 29 Jan 2019

time: 2:00 pm

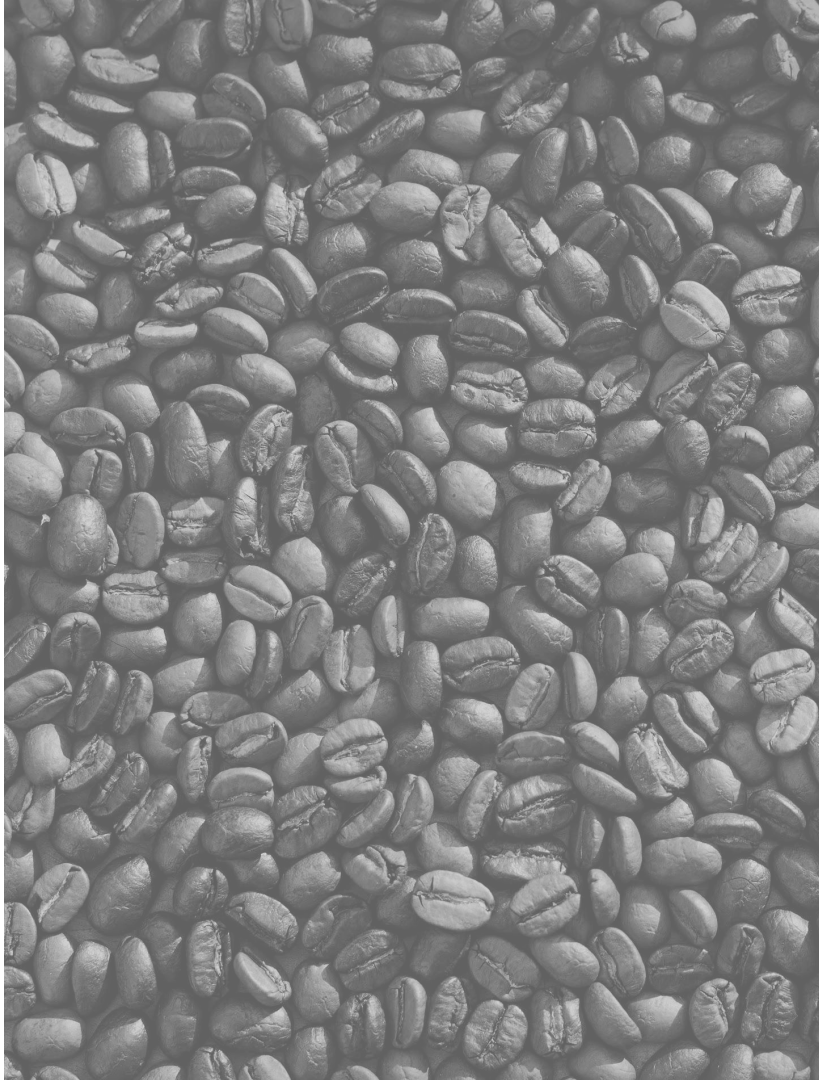
location: Foundery Coffee Pub

who: Emma, Idrys, Xuan, Hoi Man

Some of the interview questions we asked:

- What's your daily life like?
- What bothers you the most in your day to day life?
- When did your knee problems start?
- Tell us about how you acquired your knee problems?
- How do you feel about having them?
- Have they disrupted your life and if they have how so?

Emma mentioned that her patellar tendinitis was developed from a broken leg in high school that went unchecked until it was too late. It caused a limp, knee dislocation, and a torn LCL.



Lacrosse

Emma is the goalie on the SCAD lacrosse team. Constantly exercising helps her stay in shape and keep her injured knee from deteriorating.



Always busy

Emma is a very busy person. She wakes up, goes to rehab, practices lacrosse, goes to class, works, and goes to sleep to do it all again the next day. She barely has time to do homework and cook.



Adapting

Doctors tell Emma that she will need a cane, when she is fifty, which is hard for her to come to terms with as someone who loves to move. However, she is doing her best to slow it down.



Not an early bird...

Emma has to wake up early to go to both rehab and lacrosse practice. That being said, she doesn't like waking up so early.

Second Interview

day: 31 Jan 2019

time: 2:00 pm

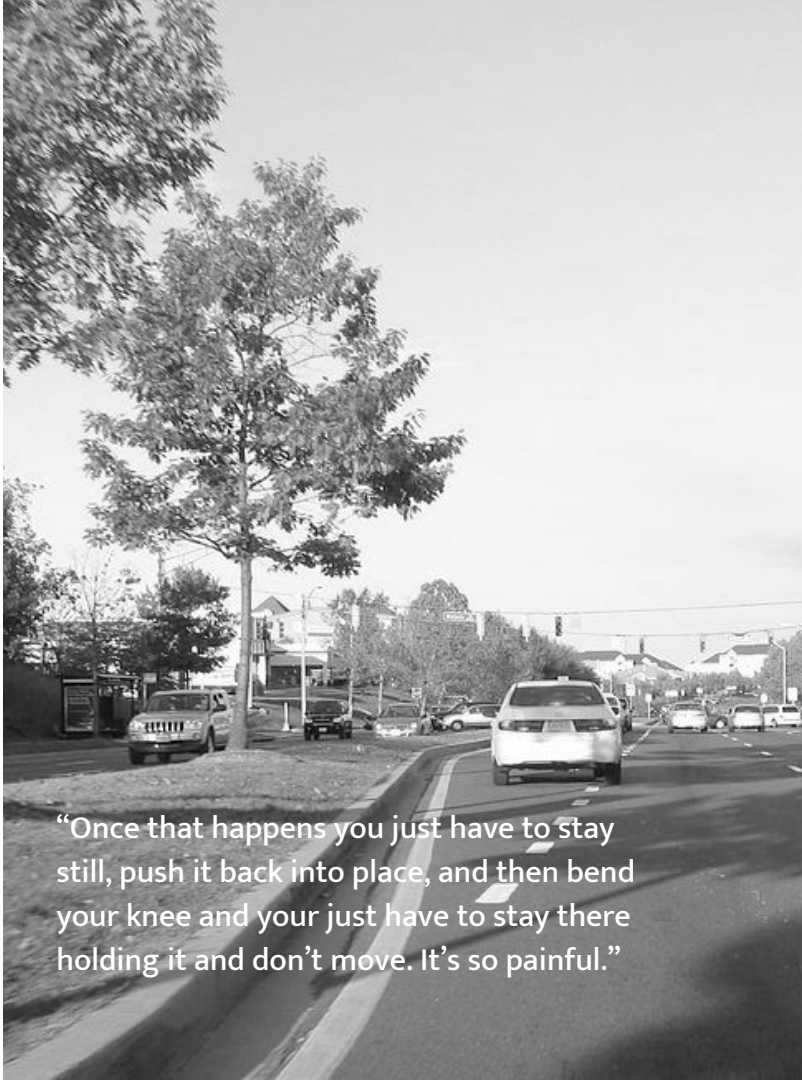
location: Foundry Coffee Pub

who: Emma, Idrys, Xuan, Hoi Man, Danlei



“If I sit for too long it hurts, if I stand for too long it hurts...”

She ended up getting a strange leg pain after week 4 in her internship. *“Sitting for 8 hours was fine, but sitting for 8 hours every day started to cause leg problems.”*



“Once that happens you just have to stay still, push it back into place, and then bend your knee and your just have to stay there holding it and don’t move. It’s so painful.”



Loves Learning about People

“I love learning about new people. One of the first conversation things that I ask people is ‘Okay, tell me your life story.’”



Althetic

Loves to move, dance, and wishes she could do parkour. Moving helps her release excess energy from her ADHD. Her advice: “If you guys are ever stressed just go run a mile.”



Coffee

Coffee is one way she calms herself down. Most of the time she presses her own coffee, but she loves the horchata at the Foxy Loxy and espresso at Savannah Coffee Roasters.



Biggest Microaggression

Hates how people have so much trouble spelling her last name, despite it being a very simple last name. “It’s like having the last name Brown, in Brazil.”

Home

3 Bedrooms

2 Floors

Small but nice

- Emma likes having a room to herself
- She refuses to do homework in her room in order to keep it as a calm relaxing space
- Wishes her house was more decorated but doesn't have the time or money to do so
- Has lots of trouble walking up stairs and wishes her room was on the ground floor
- Her girlfriend had to help her up the stairs the night before the interview

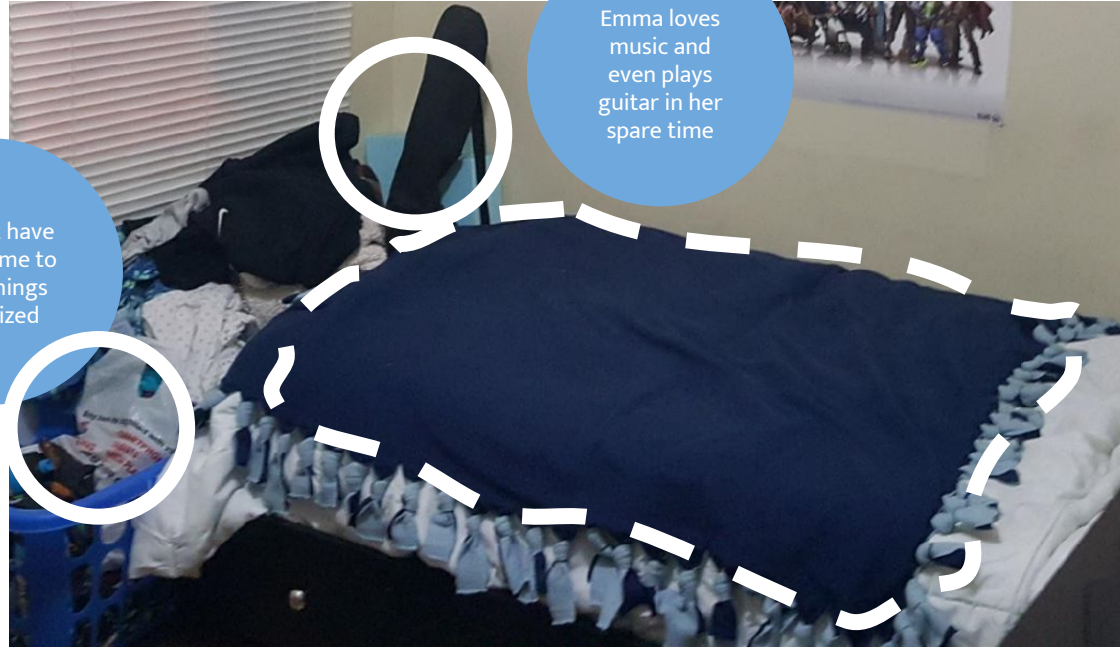


Sleep Position

“I can sleep on my left, but **never on my right** anymore ... I feel like my bones are being **pushed into my body** sleeping on the right.”

She feel uncomfortable sleeping on back. She wakes up if she isn't sleeping on her side.

She used to sleep on stomach but can't now because her knee caps are so sensitive.



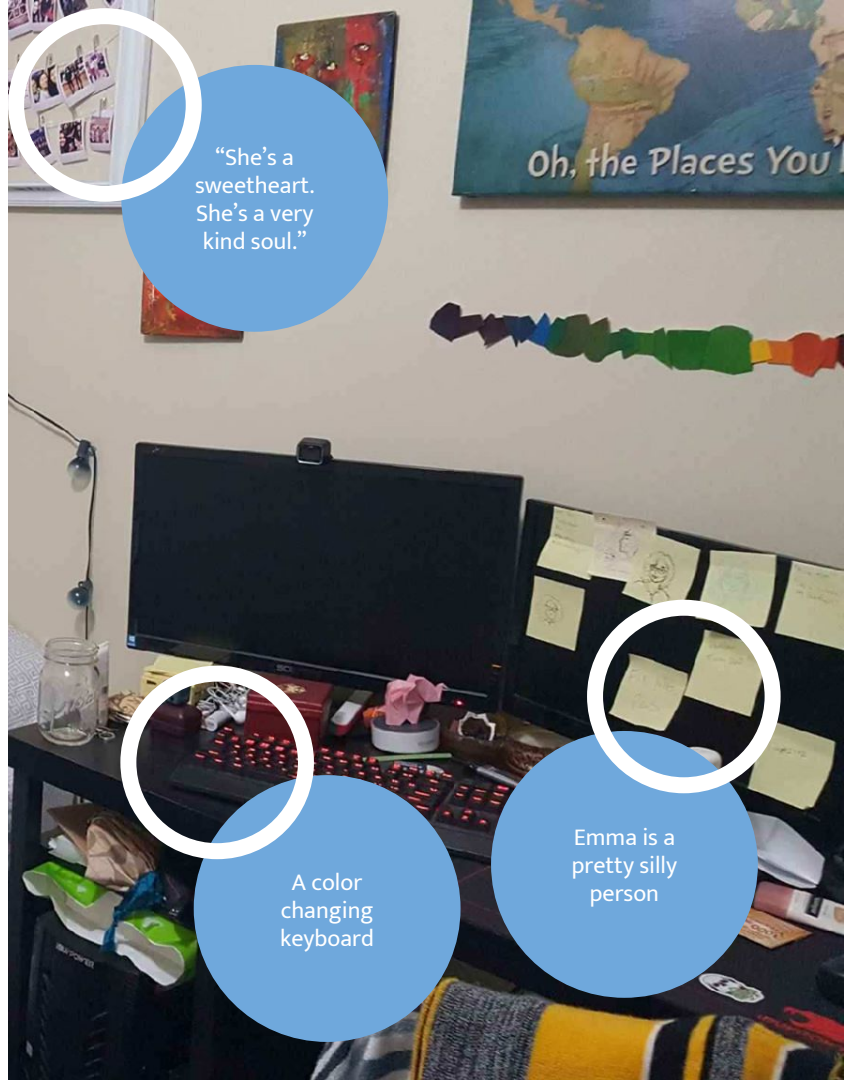
Emma loves music and even plays guitar in her spare time

Doesn't have much time to keep things organized

Family and Friends

- Has a very big Brazilian family with 54 first cousins
- Grew up in a close knit Asian Latin Community
- Misses her family but feels like going to college has made her an individual and given her a new perspective
- She has a girlfriend who is really empathetic and helps her through rough times
- Most of her friends are from ID but she has a group of older friends who are also Latin American

“It’s nice to have someone who can really **calm** me down, really keep my head in **check**.”



“She’s a sweetheart. She’s a very kind soul.”

A color changing keyboard

Emma is a pretty silly person



“She’s my
phone
background,
my computer
screen...”

Emma plays
Junkrat, Lucio,
Sombra, and
Reinhardt the
most often

Hobbies

“DC or Marvel?”

“I don’t ever pick one. I like
both sides.”

Emma loves comics. She grew up on DC comics, but started getting into Marvel comics too, when she was older. Her favourite character is Wonder Woman.

She also likes to play first person shooter games such as: Overwatch, Fortnite, and Destiny.

Life and Study

- Does most of her work at Gulfstream
- Likes how everything is on the same floor
- Hates having to stand in Hopson's class to sketch
- She stands with one leg on a chair for support
- Sits whenever she can (Even if she isn't supposed to)
- Hasn't told him about her injury because she doesn't want to make a fuss

“I can't **stand** for **two hours**.”



Emma's Bag?

- Hates bags even though she thinks purses are pretty
- Doesn't like having the extra weight
- "Traumatized" by having to carry lots of supplies in foundations classes
- Wasn't carrying her phone during the second interview (though she still uses it often)
- She is a forgetful person
- Anxious about having her phone and wallet together
- Keeps everything in her pockets and at gulfstream where she can keep track of it
- Grew up near DC where personal items can be stolen easily
- When she absolutely has to carry a bag it just has her laptop, her sketchbook, some pencils, and that's it

"Fun fact: I normally do not carry a bag with me."



Observation

day: 02 Feb 2019

time: 3:00 pm

location: SCAD athletic field

who: Emma, Xuan



Observation about how Emma acted
during the Lacrosse game

Position: Guard

When Emma was standing, she put her
weight on her left leg because her
right knee cannot bear
too much pressure

*“I’m lucky my position is a goalie, so I am a
lot of stationary than the other players”*

Emma's knee brace

**“Before it would just pop, and it would be like
“Ah my knee is over here!””**

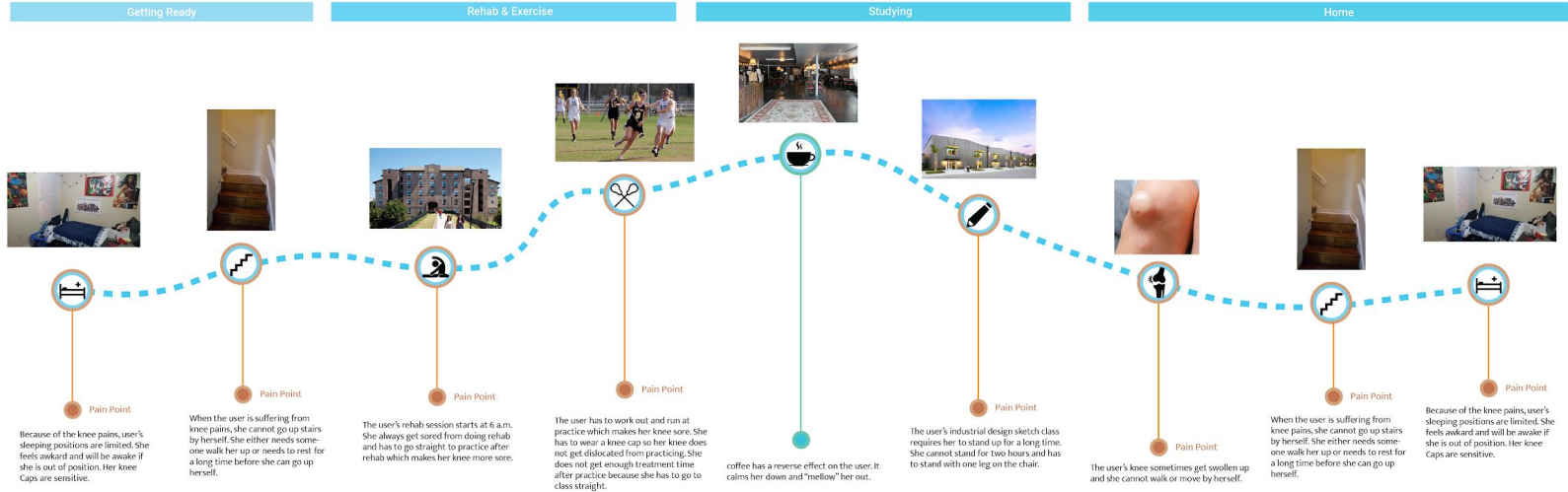
- When she is running she can keep running and her knee will stay in place
- It holds everything together and doesn't let the knee dislocate
- Knee used to slide out all the time
- If it slid out and she bent it her whole leg would break
- She would have to push her knee back into place, bend her leg, and hold it for a while
- After getting the brace, this hasn't happened again



Emma's Pain points

STEPS &
TOUCH POINTS

PAIN POINTS



PAIN POINTS

TOUCH POINTS

EMOTION

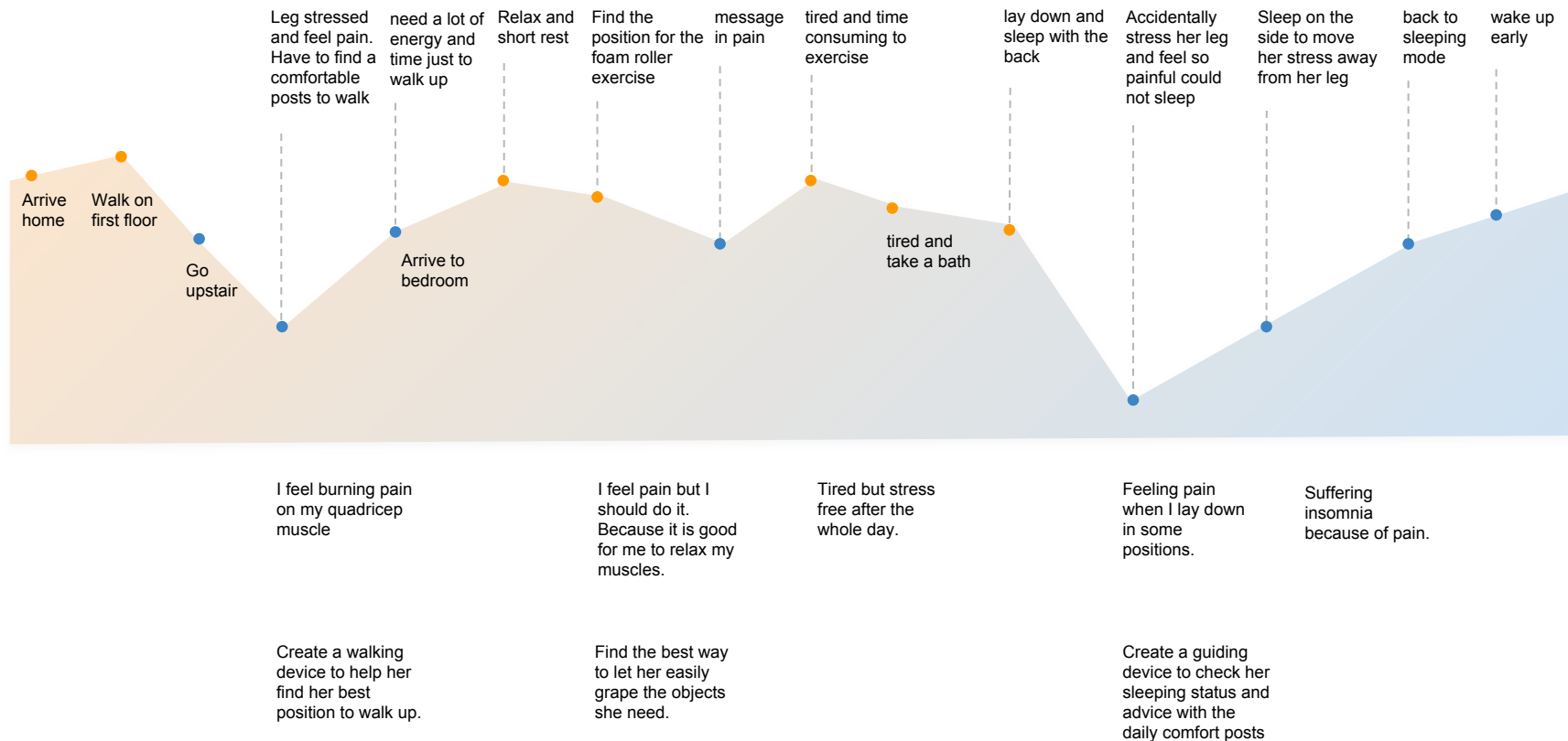
THINKING

OPPORTUNITIES

Arrive Home

Exercise

Sleep





Immediate Care

“ **Swelling** on knee can reach the size of an **egg** in the worst situations. I have to take 8 Ibuprofen or 1600ml to prevent knee from **exploding** in that kind of situation ”

Rehab sessions,

Emma goes to rehab at 6 a.m, twice a week. She does a lot of hip exercises to keep her hips strong, which can take away the weight that knee bears. She usually uses a Theraband. She puts it above the knee and does hip extensions, sitting and holding that position for a minute. She sometimes does ankle exercises when her ankle is weak. Because she leans most of her weight on one leg when she stand, Emma is currently doing a balance exercise, where she has to stand on her bad leg on squishy foam.

Ice,

It reduces swelling, without drugs.

Foam roll,

A cylinder of dense foam that breaks knots.

Peanut,

Two tennis balls connected by a joint that massage out knots.

A solid teal circle is positioned on the left side of the slide, partially overlapping the text.A thin, dark gray wavy line curves from the top right towards the bottom right of the slide.

Problem Spaces

Pain Area



Lifting Leg Motions

Emma has more trouble walking on steps and hilly surfaces than she does on flat surfaces. A solution could lie in figuring out how to make it easier for her to deal with stepping up.



Stepping

Emma has to be careful when she is running, because her knee will hurt if she steps weird. A product or service could be developed to make sure she keeps the right posture while running.



Standing and Sitting

Emma has difficulties maintaining a standing or sitting position for long periods of time. An application or product could be designed so she knows exactly when to switch from standing to sitting or vice versa.



Sleeping

Emma has difficulties sleeping. She can't sleep on her back or side. Perhaps something could be developed to make her knee more comfortable while sleeping.



Schedule

Emma has a very cramped schedule and barely has time to even cook. Reducing the time it takes for her to relieve pain and massage knots could be a solution to the problem.



Knots

Emma gets a lot of knots in her injured leg. She says that someone putting their body weight on them is the best way to relieve them. Her foam roll and peanut aren't too effective and could be improved.

Moving Forward



Diary Study

day: February 6, 2019

duration: a week

location: anywhere

who: Emma



Contacting Experts

day: undecided

time: undecided

location: undecided

who: Emma, Idrys, Xuan, Hoi Man, Danlei

Executive Summary

Emma is a driven, decisive, energetic busy industrial design student, who loves to move and plays lacrosse. Emma developed Patellar Tendonitis after a broken leg went unchecked for several years and is constantly suffering from soreness, knots, the inability to sit or stand for long periods of time, knee popping, and balance issues. Emma plays lacrosse and goes to rehab to help slow the deterioration of her knee, but her problems have caused a lot of hardship in her life.

Knex is a three part system that can help detect and warn its user about problems they might encounter in the future. The knee brace collects movement data from the user using electromyography, while the bracelet collects data on what times and conditions the user is feeling pain. This data is then analyzed and used to predict when the user needs to change position, when the user might get knot, when the user likely to encounter pain, and when the user is walking funny, so the user can deal with these problems, before they even occur. The AI can also create a recommended massage based on this data for the user, through the massager, which the user can change and customize if they so choose.

With this app Emma will know when she is likely to get a knot, when she might feel pain, when she needs to change position, and when she is walking incorrectly. With this information, Emma can take precautions to prevent these problems from manifesting and causing issues in her daily life. The lightweight brace also prevents Emma's knee from popping out, in addition to gathering data. Emma can also use the massager at home, while she is sketching and working on her laptop, giving her a few more minutes in the day.

Our team came up with this solution through our research on Emma's life through interviews and a diary study, in addition to secondary research on electromyography and hydro massaging. We abstracted Emma's daily life through experience maps in order to uncover what problems were causing her the most issues. Then we brainstormed solutions around these problems, and after much group debating, we ended up combining two of our solutions, in order to create Knex.

Diary Study

2/7/2019

Thursday

6:50 am

During Rehab

Hip to knee pain from foam block exercise
Ankle pain from six direction exercise

1:40 pm

Pain Point

Pain from rushing up stairs at
boundary village

11:00 pm

Relief Methods

Woke up from sleep with knee completely
swollen and unable to walk. Took advil for
the pain

2/8/2019

Friday

9:00 pm

Pain Point

Bad swelling that lasted till I went to
sleep at 12:00pm

2/9/2019

Saturday

4:19 pm

Pain Point

Knee popped out of place while standing at
Gulfstream. Worked till 6:37 until I got to sit

7:30 pm

Pain Point

Knee popped back into place at target

2/10/2019

Sunday

2:00 am

Pain Point

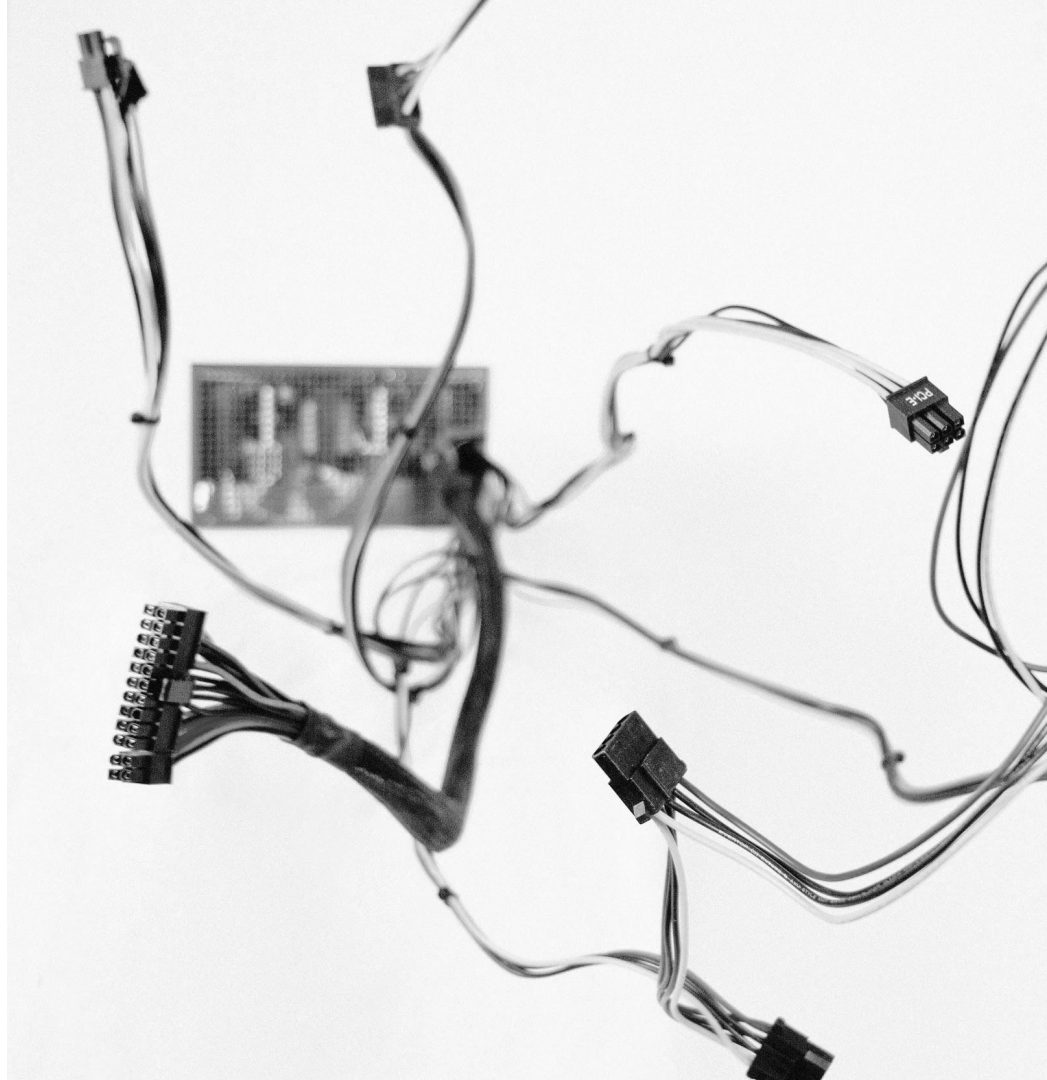
Random sharp pain woke me up. Knee slid
out while I was sleeping, and then
I bent my leg

8:45 am

Pain Point

Had to stand on one leg to make breakfast,
since knee was still dislocated,
which was uncomfortable

Technology Research



Electromyography

Records movement of muscles through the bursts of electricity created by muscle contractions

- Signals start in the motor cortex and are carried to upper motor neurons and then lower motor neurons.
- When the signal reaches the lower motor neuron, which instigates the motion, they release calcium ions, which changes the tension in the muscles
- Depolarization occurs which is what EMGs detect
- Recently needleless electromyography tech has been discovered.

Farnsworth, Bryn. "What Is EMG (Electromyography) and How Does It Work?" *imotions*. <https://imotions.com/blog/electromyography-101/>





Existing Product

Myo Armband

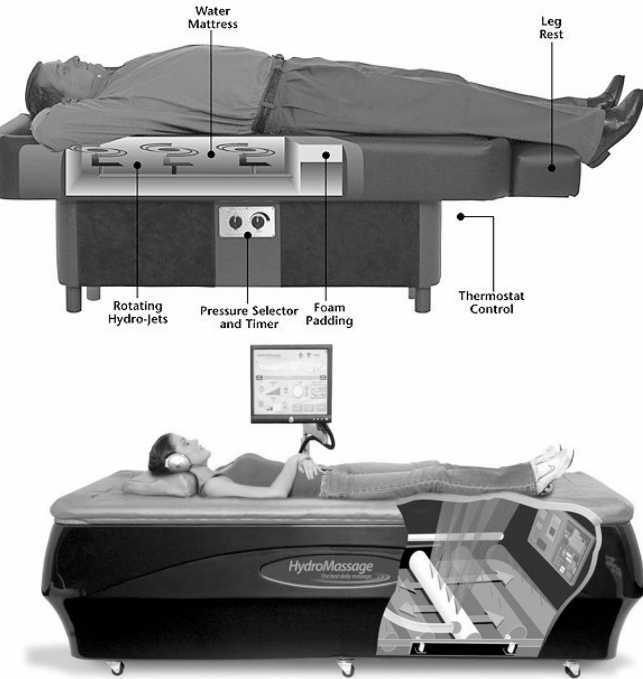
- Special armband that can detect electrical signals from the arm and use them to control computers, prosthetics, and even drones
- Senses motion, orientation, and rotation of the forearm and sends this information via bluetooth to smart devices
- Inside are several EMG electrical units which have a small circuit board and two batteries within each section with metal facing outward to detect the electromagnetic signals.

“How Does the Myo Armband Work?” *North*.

<https://support.getmyo.com/hc/en-us/articles/202532376-How-does-the-Myo-armband-work>

Stern, Becky. “Inside Myo.” *adafruit*.

<https://learn.adafruit.com/myo-armband-teardown>



Hydromassage

Hydromassage is the use of water pressure to apply massage techniques to the human body.

- Purported to help alleviate muscle and soft tissue injuries caused by low back pain, arthritis, chronic and acute pain, neck injuries, TMJ, sports injuries, pregnancy discomforts, Crohn's Disease, insomnia, spondylolysis, multiple sclerosis, lupus, fibromyalgia, tendinitis, and stress management and many more diseases and ailments.



https://en.wikipedia.org/wiki/Hydro_massage

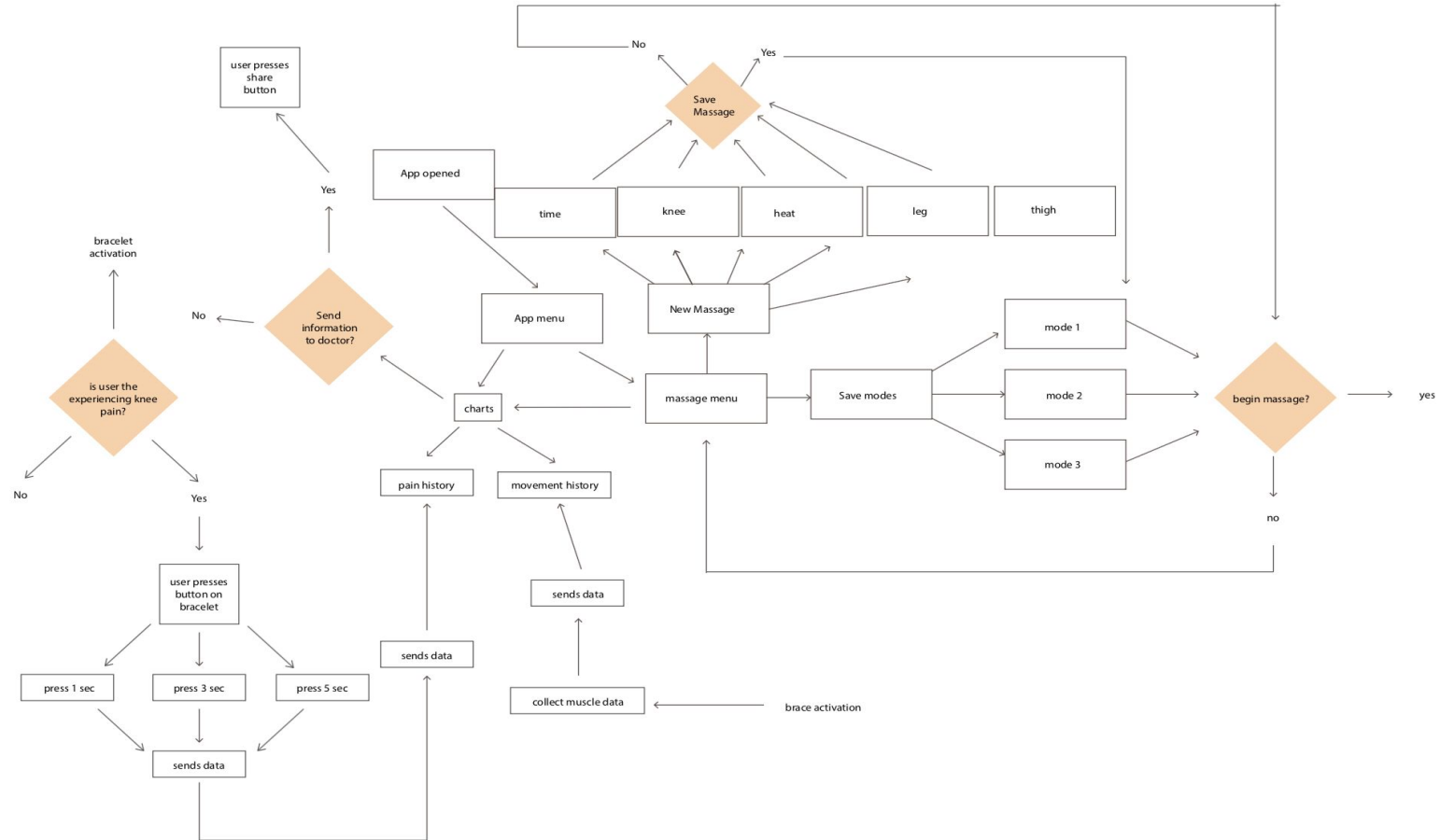


A three-part system that can detect pain, analyze it, and help prevent it from occurring. It consists of a special light weight brace, a bracelet, and a massager.

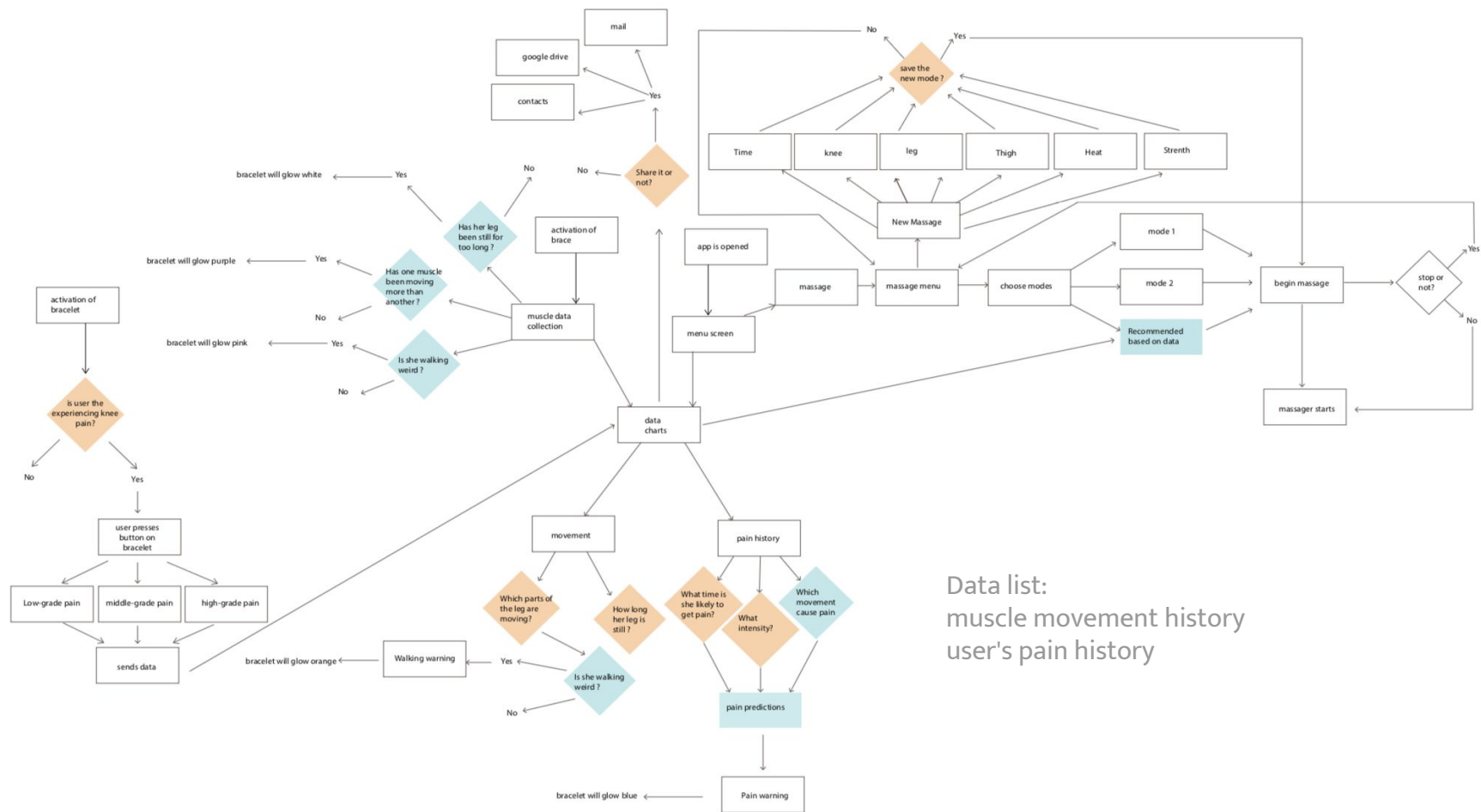
User Flow



Flow Chart without AI

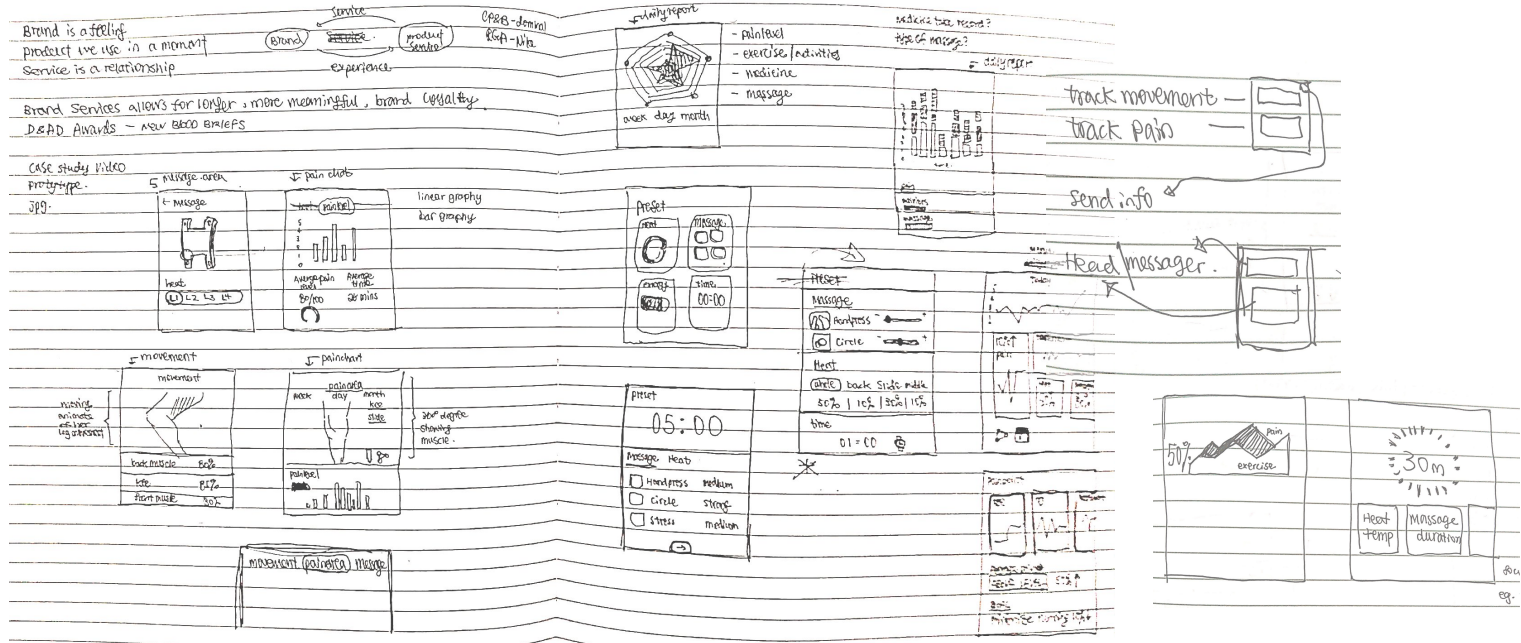


Flow Chart with AI



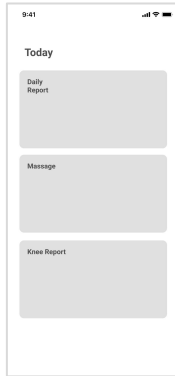
Data list:
muscle movement history
user's pain history

wireframes

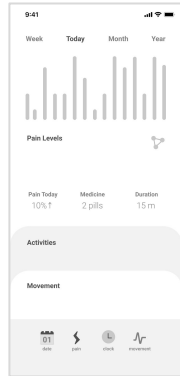


wireframes

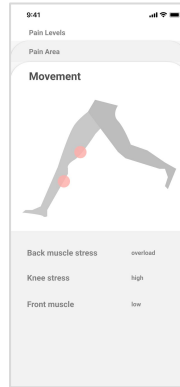
menu



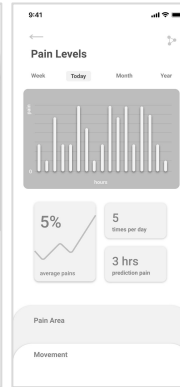
daily report



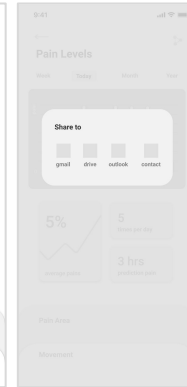
movement



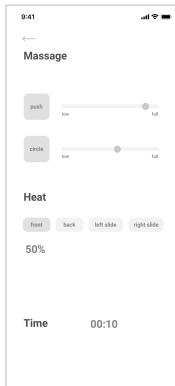
pain levels



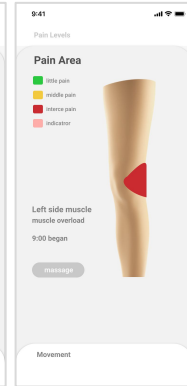
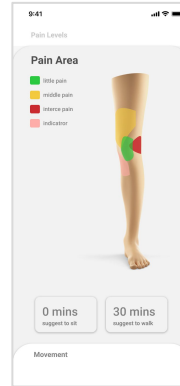
share



massager idea 1 massager idea 2



pain area (3d animation)





connection



menu



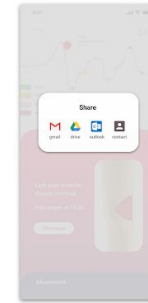
daily report



pain levels



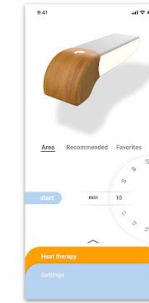
share



movement



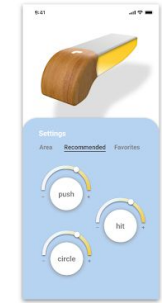
massager time

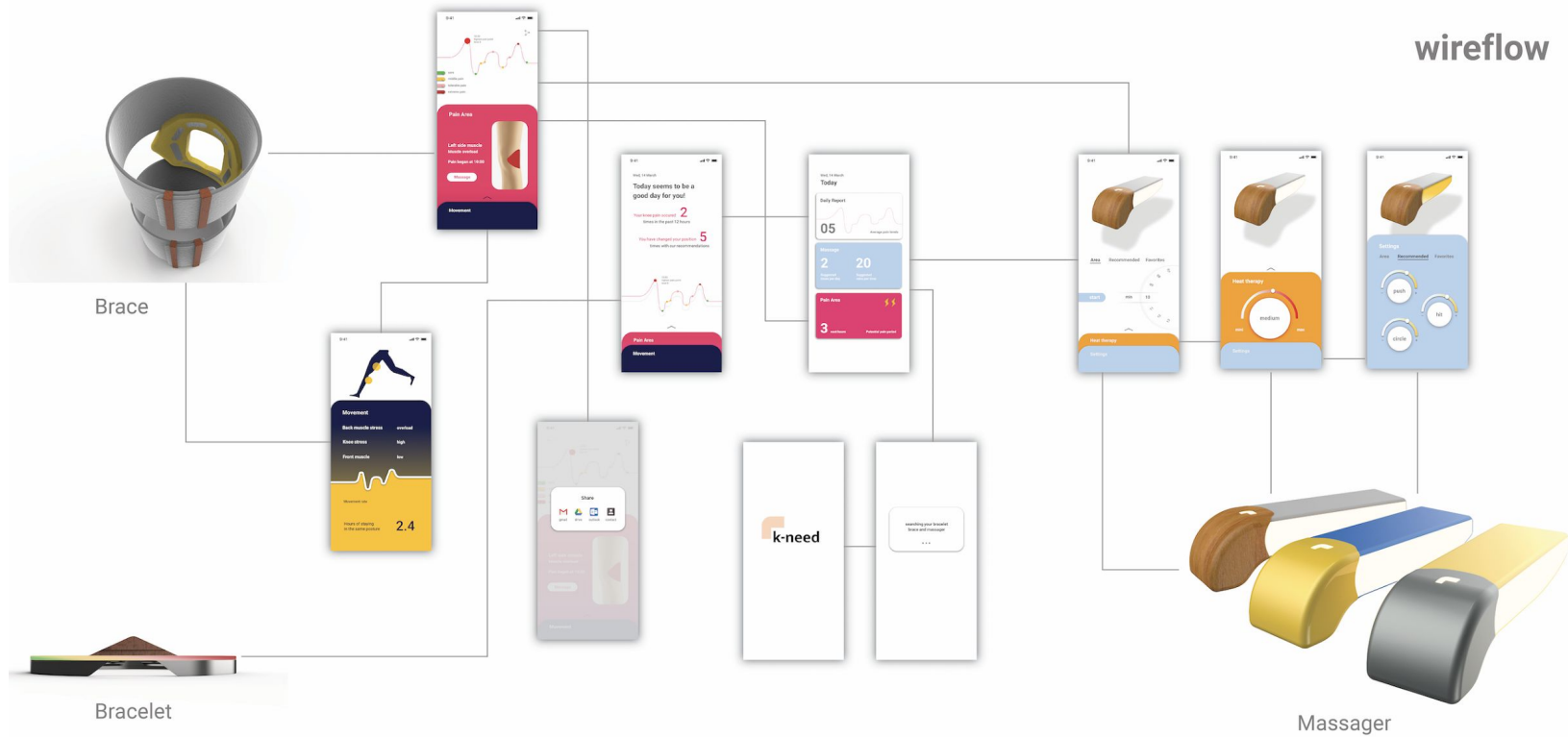


massager heat



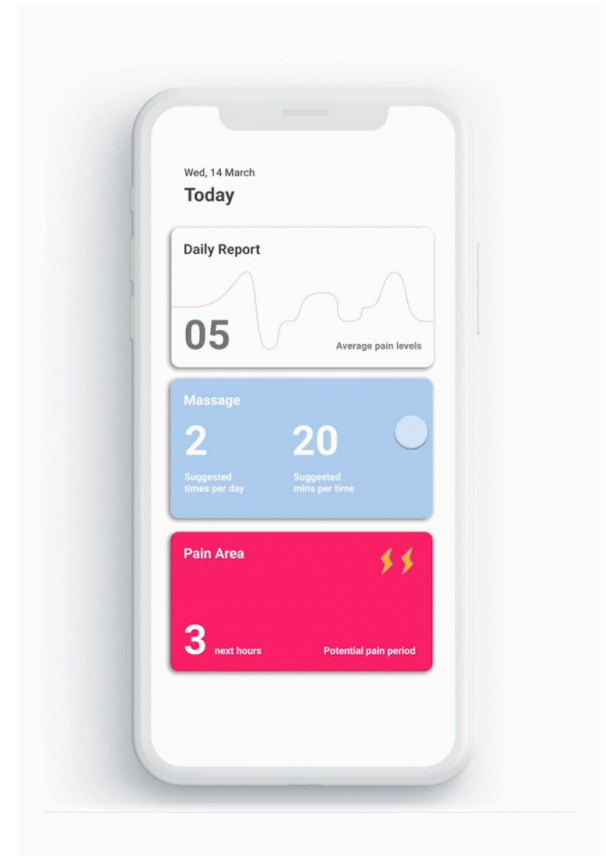
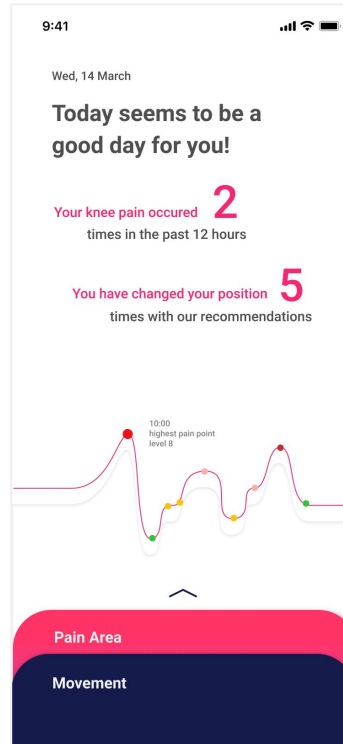
massager modes





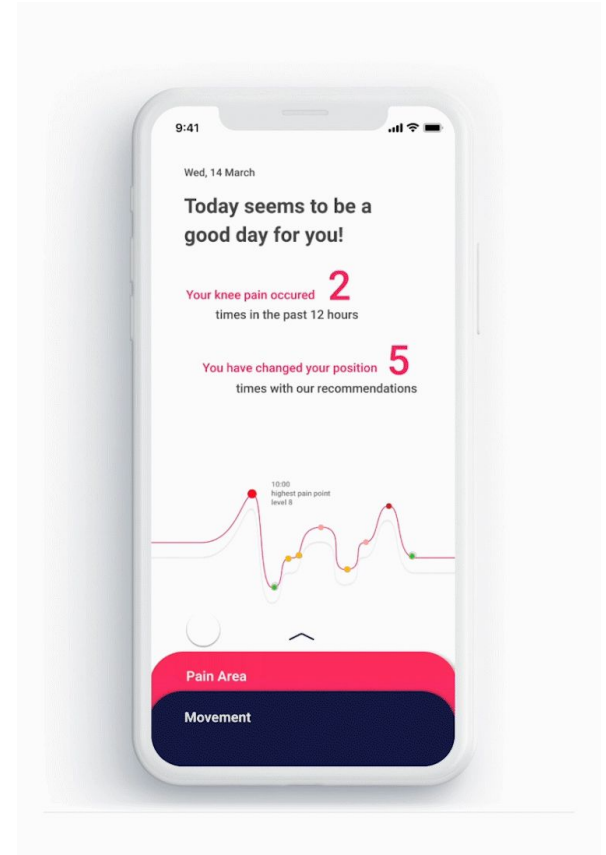
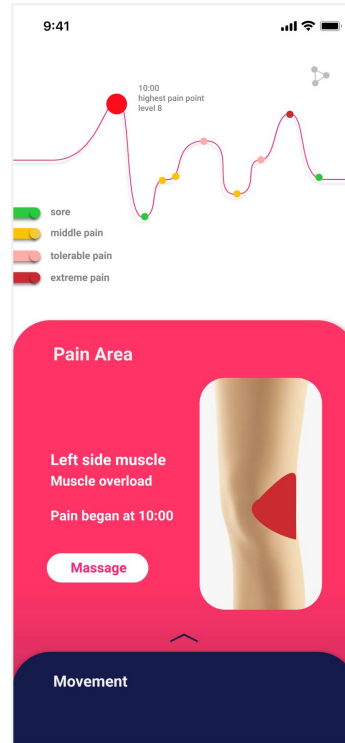
Daily Report

By analyzing the daily user routine, the apps will predict when the next possible pain point likely occurs and recommend position changes.



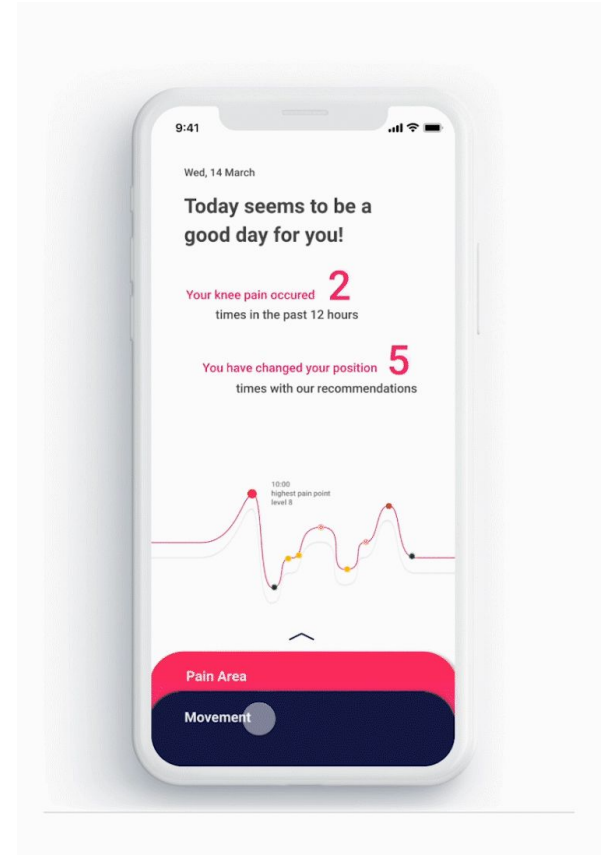
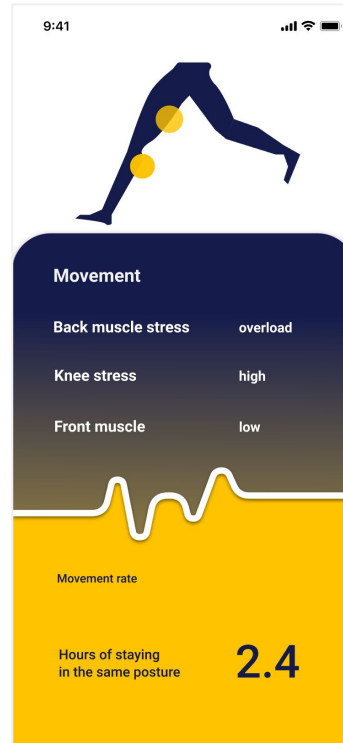
Pain Area

It shows the user muscle area and level of pain in the whole week. The apps will recommend the massage methods for user to relax the pain area.



Movement

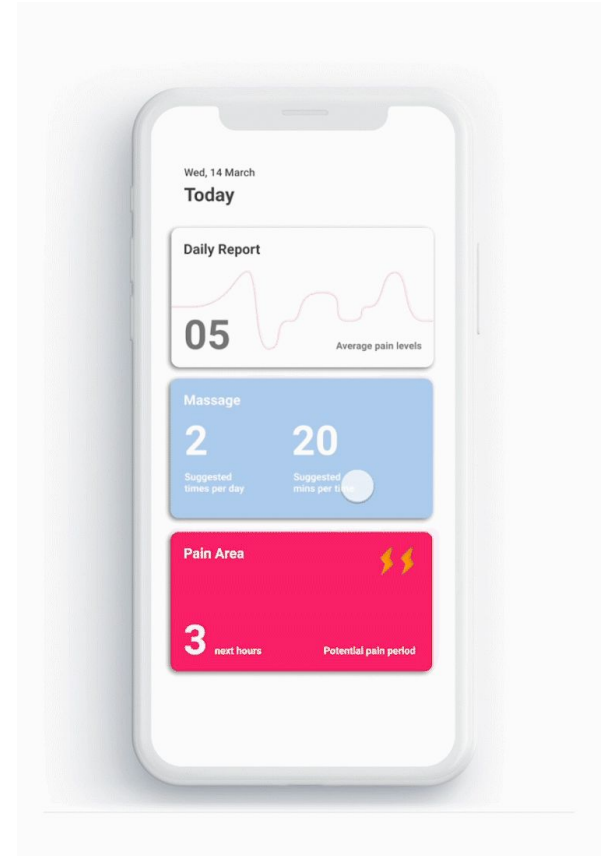
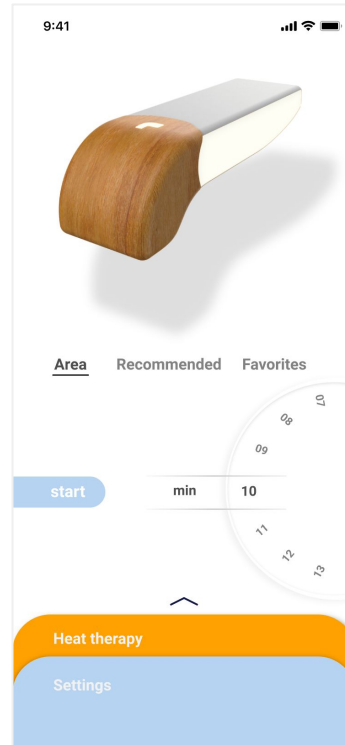
The brace will record the everyday movement of the user in the app. The system will categorize the muscle data to different levels of stress.



Massager

The system will recommend the user a massage mode based on the data collected from the user's pain levels and muscle stress.

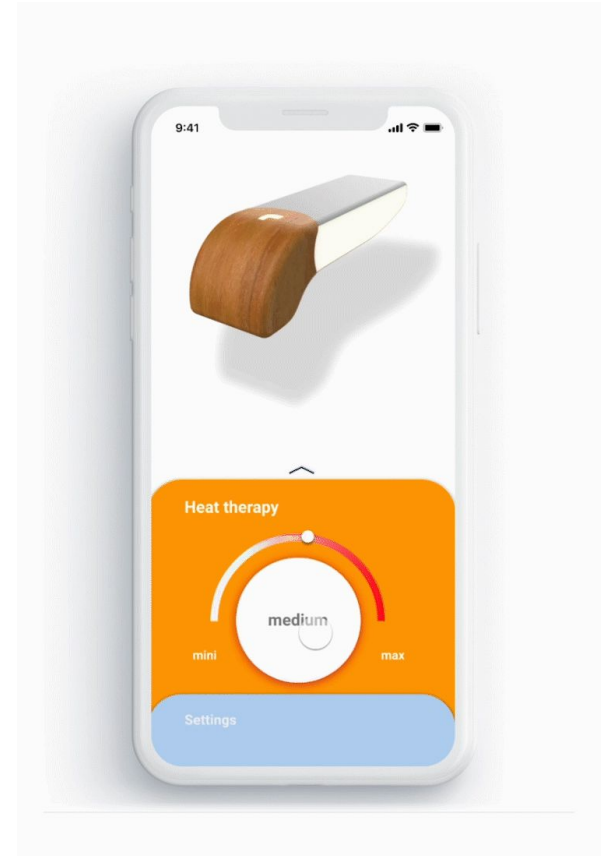
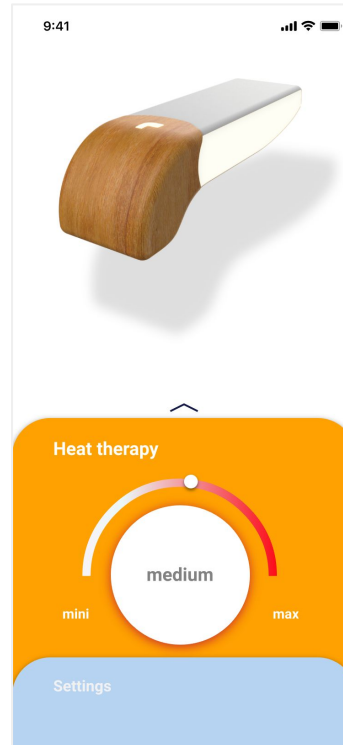
The user can also use the suggested modes from their trainers and doctors for specific treatments.



Massager

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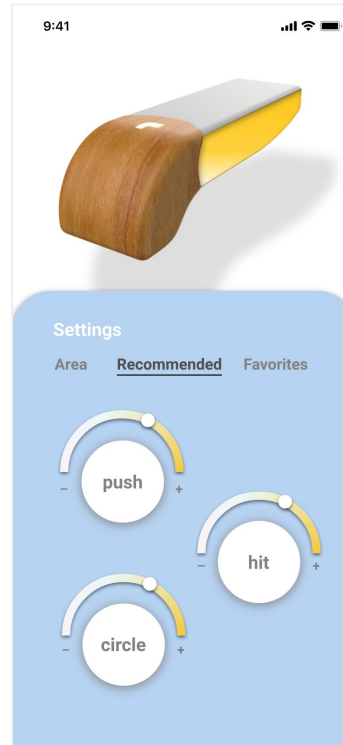
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Massager

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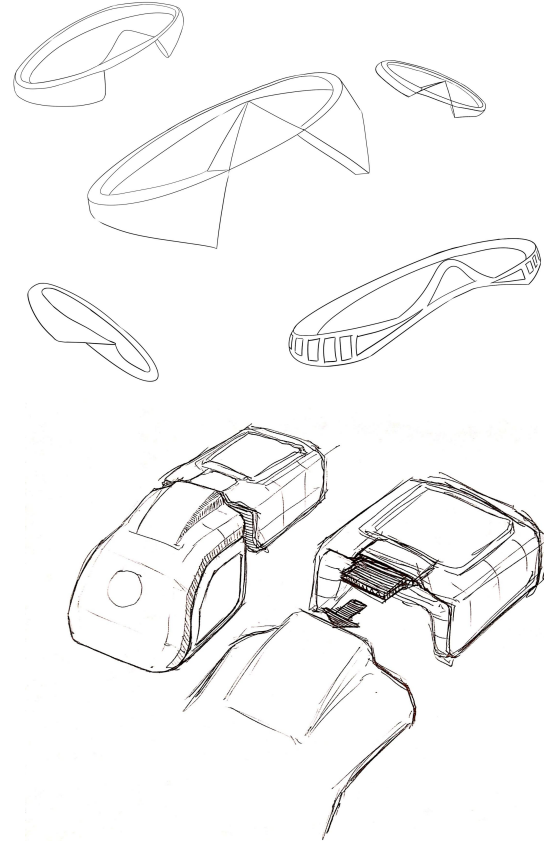
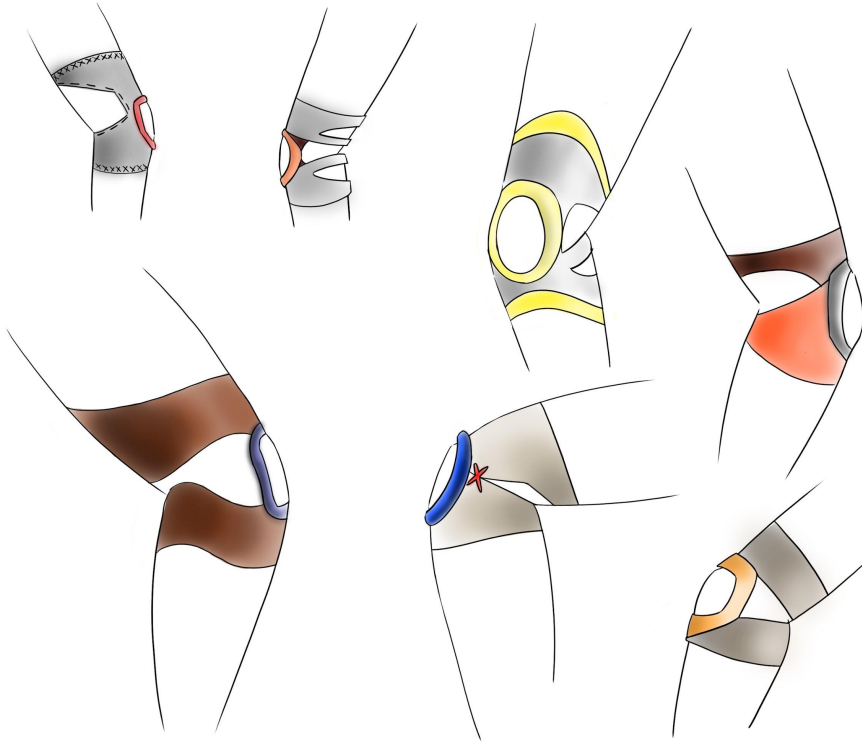
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MOOD BOARD



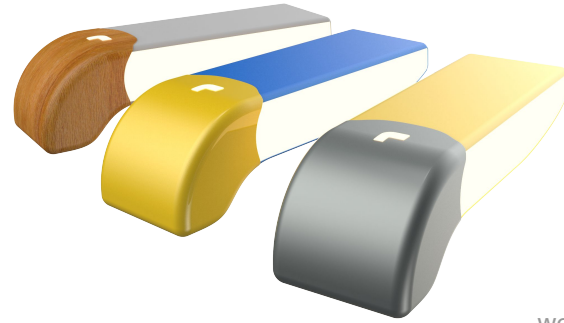
Ideation Sketches



massager top



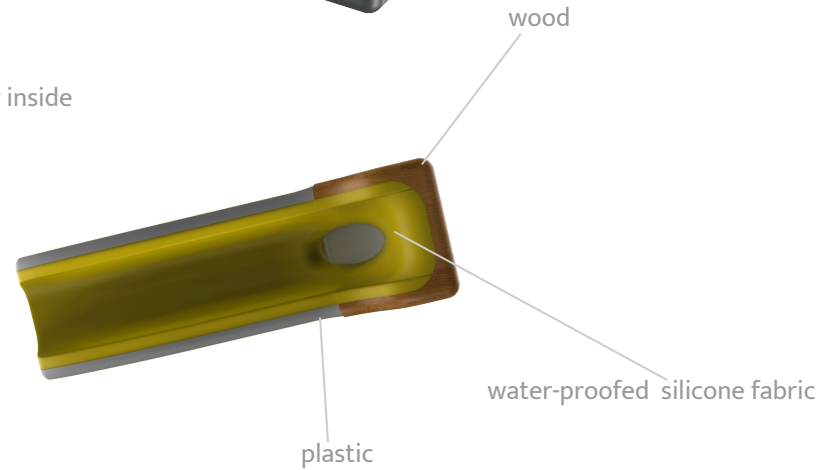
massager options

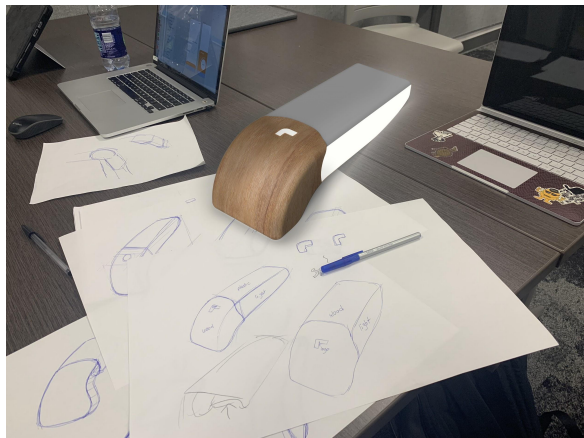


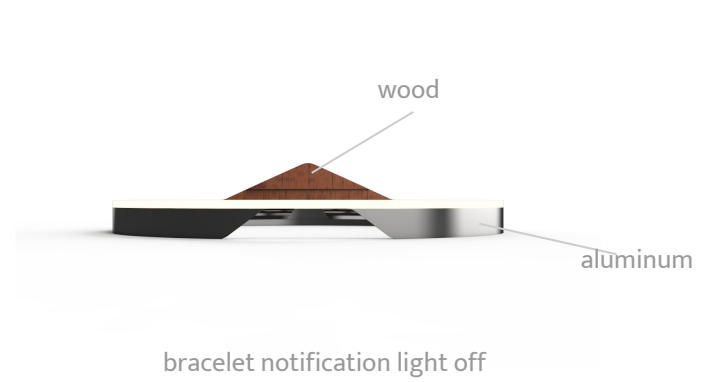
massager side



massager inside

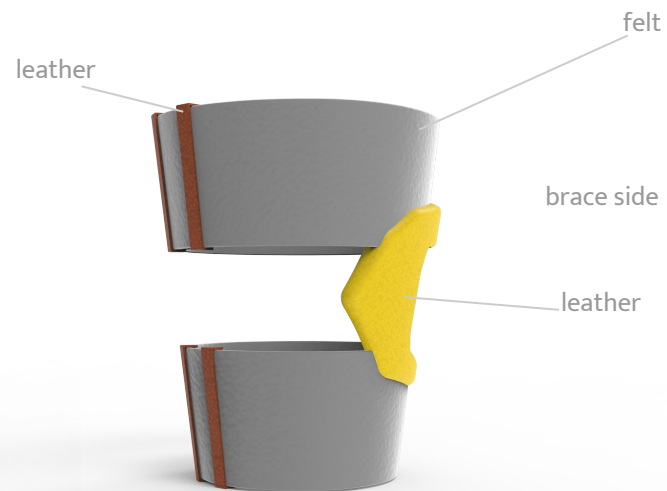
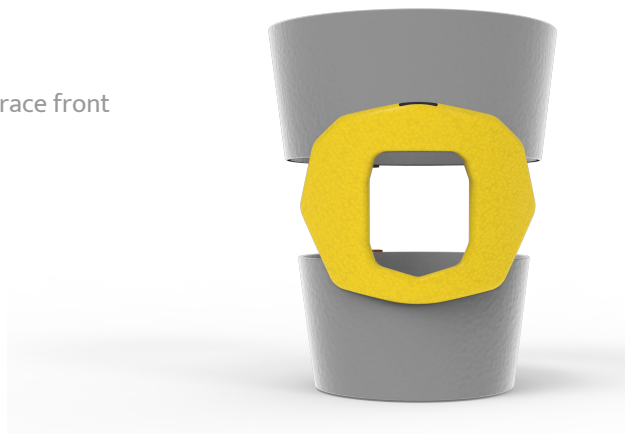






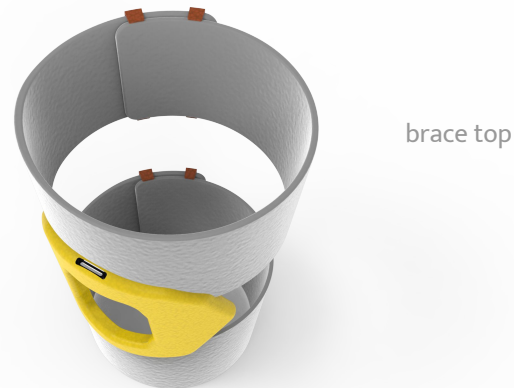
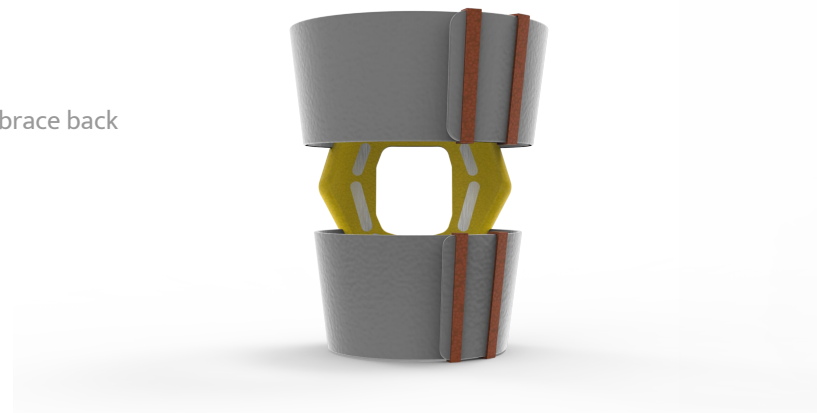


brace front



brace side

brace back



brace top

Future experience map

