PROJECT FOUR: MILESTONE 2 – COVER PAGE

Team Number: Thurs-07

Please list full names and MacID's of all *present* Team Members.

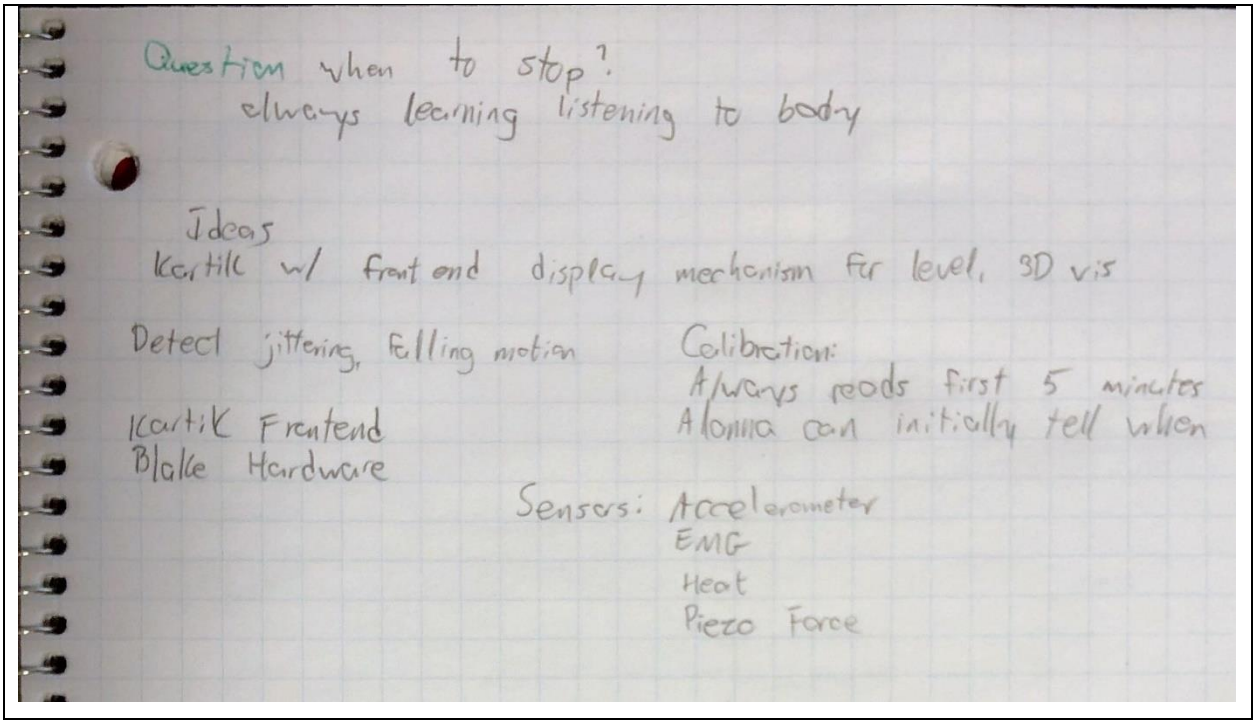
Full Name:	MacID:
Blake Freer	freerb
Samuel Parent	parens4
Kartik Chaudhari	chaudk4
Dehe Meng	mengd9

MILESTONE 2.1 – CLIENT NOTES

Team Number: Thurs-07

You should have already completed this task individually prior to Design Studio/Lab B for Week 8.

1. Compile your team's notes from the client Q&A visit.



Alanna interview 2

Question why didn't first grabber work?
Not strong enough, became "weaponized"
Kids play with everything

Questions
Canvas size => GIANT, but expensive and hard to stretch 4' x 4'
sometimes small if large not available
Righthanded, small hands => ring size 5-6
left used only to support
Prefers to work large as flows with creative process
When FIBRO is active, (soft + seamless)

Question SAM
likes ~1" brush
what makes things easier to grip
↳ large brushes / squeegies => 4"x5" paddles, 3/8" thick
sometimes gets stuck in painting when smaller details necessary
Wide Handle + Small Brush => dream

Question
Where is fibro pain?
pain not like exercise
↳ sometimes hard to tell
↑ "radiating fire spreading"
fibro => feels like muscle fire in torso + arms
↳same location as lymphdema + nerve damage
most pain is upper body
Support for arm: all conditions together
weight could be beared by torso if no tight straps used
Must be flexible

Question
Fibro => larger contact better
lymph vest uncomfortable @ seams
Most available garments are condition specific but
incompatible w/ other conditions

Question
Cutting veg less because knife is hard to use
Prepare stews all winter → squash, potato, oth veg, now buy stock
quinoa but kids don't like
5'1 ½"
Can hold up to 10 lbs

Question
Large, flat easiest to grip

MILESTONE 2.2 – RESEARCH ASSIGNMENT

Team Number: Thurs-07

You should have already completed this task individually prior to Design Studio/Lab B for week 8.

1. Copy-and-paste each team member's research assignment on the following pages (1 assignment per page)
   → Be sure to indicate each team member's Name and MacID

See individual worksheet for assignment specification.

We are asking that you submit your work on both the team and individual worksheets. It does seem redundant, but there are valid reasons for this:

1. Each team member needs to submit their research assignment with the **Milestone Two Individual Worksheets** document so that it can be ***graded***
2. Compiling your individual work into this **Milestone Two Team Worksheets** document allows you to readily access your team member's work
   a. This will be especially helpful when completing the rest of the milestone

Team Number: Thurs-07

Name: Blake Freer	MacID: freerb

Fibromyalgia syndrome (FM) is a complex condition characterized by widespread pain around the body. It is relatively common, with estimates suggesting that up to 3% of people are affected [1], particularly women, but many of these cases may be unknown as it is difficult to diagnose [2]. While it may be caused by changes in pain response in the nervous system [2] due to physical or emotional trauma, the exact cause is unknown. In addition to pain, common symptoms include hypersensitivity, fatigue, stiffness, spasms, and concentration issues [3]. A proposed product for the Client will be designed to assist in reducing the effects of FM, so the behaviour of this condition is vital to understand.

FM causes the body to become highly sensitive to all forms of stimulation. For example, a change in weather may be enough to trigger a flare up [2]. The pain is described as feeling like fire in one's muscles that spreads throughout the body [2]. This extreme sensitivity, combined with the severity of a flare, makes FM a highly painful condition. Additional triggers include changes in exercise routine, changes in sleep patterns, hormonal shifts, and stress [4]. Exercising is a particularly strange trigger. Exercising is recommended for people with FM, especially low intensity aerobic activity such as tai chi and yoga [5]. However, excess exercise may stress the muscles, therefore inducing a flare up [4]. People living with this condition must learn their own body in order to understand how much exercise is beneficial. Pacing is important for patients, as the quantity and frequency of activities is also crucial.

There may be some signs that a flare up is approaching. According to a survey by The Mighty, some people reported experiencing twitching, exhaustion, stiffness, tingling, and pressure in their body [6], among many others. This survey shows that fibromyalgia varies significantly between patients. Additionally, many of the signs of an incoming flare up cause changes to the regular motion of the patient, such as twitching or stiffness. These effects may be significant enough to detect by an external system, which could forewarn the patient of an incoming flare up, possibly providing enough warning to mitigate the pain. This will be a topic that is explored in this project.

Another interesting symptom of FM is what is known as "fibro fog." This common symptom involves a temporary impairment to regular cognitive functions such as forgetfulness, disorientation, confusion, and attention issues [7]. Like with many things related to FM, the cause of fibro fog is still unknown [7]. Exercise may play a role in reducing fibro fog, but this may be due to improved sleep after exercising, which itself improves brain function.

References

[1] A. Deodhar and D. A. Marcus, "Fibromyalgia Definition and Epidemiology," in *Fibromyalgia*, New York, Springer Science, 2011, pp. 9-21.

[2] National Health Service, "Fibromyalgia," National Health Service of the United Kingdom, 20 February 2019. [Online]. Available: https://www.nhs.uk/conditions/fibromyalgia/. [Accessed 10 March 2021].

[3] Besso Clinic, "Do You Have Fibromyalgia? 10 Red Flags to Watch For," Besso Clinic of Chiropractic Incorporated, [Online]. Available: https://bessoclinic.com/do-you-have-fibromyalgia-10-red-flags-to-watch-for/. [Accessed 10 March 2021].

[4] Medical News Today, "How to recognize fibromyalgia flares," Medical News Today, 20 March 2018. [Online]. Available: https://www.medicalnewstoday.com/articles/315646#what-is-a-fibromyalgia-flareup. [Accessed 10 March 2021].

[5] D. J. Clauw, "Fibromyaliga and Related Conditions," *Symposium on Pain Medicine,* vol. 90, no. 5, p. May, 2015.

[6] P. Wyant, "23 'Red Flags' That Might Mean a Fibromyalgia Flare-Up Is Coming," The Mighty, 26 May 2017. [Online]. Available: https://themighty.com/2017/05/fibromyalgia-flare-up-symptoms-red-flags/. [Accessed 10 March 2021].

[7] W. Karper and S. Letvak, "Fibromyalgia, Fibro Fog, and Exercise," in *Holistic Nursing Practice*, Wolters Kluwer Health, 2015, pp. 190-193.

Team Number: Thurs-07

Name: Kartik Chaudhari	MacID: chaudk4

What is your question?

How can artists with physical limitations work more efficiently?

What is your answer?

When an artist has a physical disability, it may affect their productivity at work due to their discomfort, causing them to stop working on their project until they feel well enough to resume it [1]. As a result of this situation, artists with physical disabilities must formulate a feasible solution to this dilemma in order to resolve their handicap and fulfill their passion. Adjusting one's posture is one way physically disabled artists can function more effectively [2]. Artists can also deal with physical limitations by using specially built equipment to support them [3].

For instance, artists with physical disabilities may boost their efficiency by improving their posture [2]. Artists, for example, can ensure that their chair is well supported by changing the height to a position where their feet are flat on the floor [2]. Fibromyalgia sufferers should also avoid sitting for long periods of time or crossing their legs, particularly while painting. They should use a cushion or an inflexible mattress to support their posture while lying down to paint or sleep [4]. Artists should also make sure that they have all of the tools they need in front of them and within easy reach when painting [3]. These examples show how an artist with physical disabilities can complete tasks such as painting more quickly. This knowledge will be extremely useful in our design project because it will allow us to recognize that any devices we devise to help our client paint better must take posture into account.

Secondly, artists can cope with physical limitations by using resources designed specifically to assist them [3]. A pencil grip is one device that artists with osteoarthritis (a condition affecting the smaller joints of the hand that can cause joint pain) can use. A pencil grip is a triangular device made of soft plastic that fits around a paintbrush, pencil, or pen and has a triangular shape. When holding a paintbrush or a pen, this system will offer artists a much larger surface to grip [3]. Braces (a device that can protect areas of the body that feel discomfort, e.g., a wrist brace effectively protects the wrist and prevents it from cramping) are another device that artists with physical disabilities can use [3]. Artists with ankylosing spondylitis (a condition that causes pain in the spine) will use braces to relieve tension on their joints and tendons [5]. These examples can be extremely beneficial to our project because they can assist us in developing a device that is specifically

designed to meet the needs of our client. For example, we might build a system to support the client's arm as a result of her osteoarthritis.

References:

[1] B. Sherwin, "Artists with Disabilities: Dealing with a physical or mental disability as an artist" fineartviews.com [Online]. Available: https://fineartviews.com/blog/35330/artists-with-disabilities-dealing-with-a-physical-or-mental-disability-as-an-artist. [Accessed: March-10-2021].

[2] E. Zimmerman, "Drawing Basics: When It Hurts to Draw," Artists Network [Online]. Available : https://www.artistsnetwork.com/art-mediums/drawing/drawing-basics-when-it-hurts-to-draw/. [Accessed: March-10-2021].

[3] A. Mark, Artists and Repetitive Strain Injury (RSI) [Online]. Available : https://makingamark.blogspot.com/2016/04/artists-and-repetitive-strain-injury-rsi.html [Accessed: March-10-2021].

[4] Brandi, "Can posture correction help with fibro pain? - by Dr. Brent Wells," Being Fibro Mom, [Online]. Available: https://www.beingfibromom.com/can-posture-correction-help-with-fibro-pain/ [Accessed: March-10-2021].

[5] “Axial Spondylarthritis,” Arthritis Foundation, [Online]. Available: https://www.arthritis.org/diseases/ankylosing-spondylitis. [Accessed: March-10-2021].

Team Number: Thurs-07

Name: Dehe Meng	MacID: mengd9

Include your research assignment below.

What kind of tools are commonly used for artist with physical disabilities?

What is your answer?

Some artists are struggling with physical disabilities, but they still have the passion to create artwork. Thus, many assistance tools are designed for them, and different tools have different usage, but all have the same goal: make their creation of artwork easier.

To assist artist to create art more convenient and efficient, first, a proper working environment need to be set up, for example, the table or desk is at the right height. Then, different solutions are specified for those with different type of disabilities.

The shape or art tools can be changed to fit for the demand for the artist. For those who feel painful to grab a pen, the pen can be shortened for increased control and covered with a sponge to make it easy to grab. Another method is that a pen can be put into a glove shaped device as figure 1 shows, instead of grab a pen, uses is "wearing" a pen, which can also relief pain when using it.

Figure 1 Holder Universal Tool [1]

Some assistant tool itself can become tool for art creation. For those who have a disability in walking, wheelchair is necessary for them to move freely, but it still can be turned into a painting tool just like brushes. There is an art tool called enayball that enables anyone in a wheelchair to draw. The product attaches to the chair near the floor and, as the user moves their chair, paints a line on the surface below via a ball bearing. A remote feature allows the user to lift the nib off the surface, stopping and starting the line. [2]

Figure 2 Enayball tool installed on a wheelchair [2]

With fast developing pace of technology, computerized painting programs can provide a way to create drawings that can be used alone or incorporated into larger pieces of art. Artists can use these painting programs to create basic drawing elements or shapes easily, they can use a mouse or an adaptive input device such as a joystick, trackball, or head- or eye-controlled input device so it fits for various situations. [3] For painting digitally, using a smart device such as iPad to draw rather than traditional canvas, which do not require much force act on the device.

Some biomedical technologies can also help artist to paint or draw remotely by other devices. A type of robotic arm is equipped with sensors that can detect the hand's position and movement, so the user can just move the hands and pen installed on robotic arm will complete exactly same movement as the hands. This solution can let artist to paint without using hands. Scientists are currently developing a new device that use sensors to detect the brainwave of the user and then convert it to the movement of the robotic arm, drawings and paintings can be created by just "thinking".

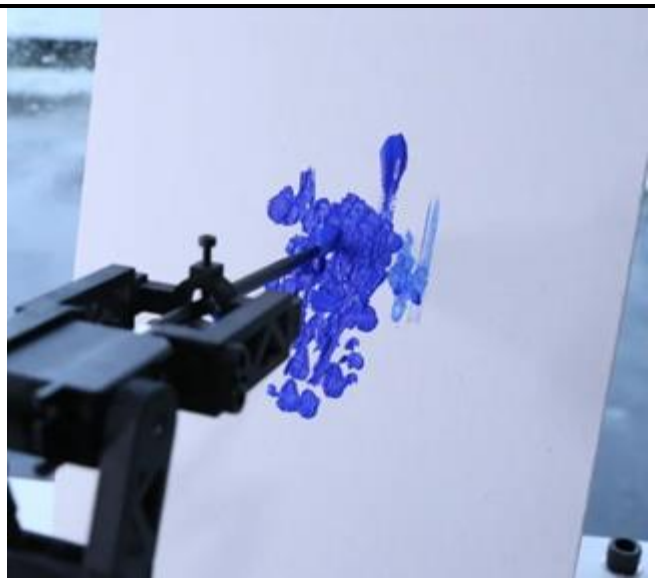


Figure 3 Painting Robotic arm [4]

From the research above, artists with disabilities can use many assistant tools to help them create artwork more comfortably. These tools can be just a special shaped pen or a robotic arm programmed with artificial intelligence. Design objects for those tools are mainly focused on make it user friendly, high accuracy and long lasting

List of sources:

[1] Arts4AllFlorida, *Holder Universal Tool*. 2021.

[2] "Enayball – Turns A Wheelchair Into A Creative Art Tool", *United Spinal Resource Center*, 2021. [Online]. Available: https://spinalcord.org/disability-products-services/enayball-turns-a-wheelchair-into-a-creative-art-tool/. [Accessed: 10- Mar- 2021].

[3] M. Coleman," Art Adaptations for Students with Physical Disabilities", *Higherlogicdownload.s3.amazonaws.com*, 2021. [Online]. Available: https://higherlogicdownload.s3.amazonaws.com/SPED/f1a9f0ef-3d66-408f-9009-876f9a536434/UploadedImages/ATforArtTechSpotlight.pdf. [Accessed: 11- Mar- 2021].

[4] *Painting Robot Arm*. 2021.

Team Number: Thurs-07

Name: Samuel Parent	MacID: parens4

What is your question?

What kind of data might we collect in order to predict fibromyalgia flare ups?

What is your answer?

Our client, Alanna, has stated multiple times that one of the biggest challenges that she faces in her daily life is unpredictability. She often forgets her limitations and pushes her body past its limit, resulting in the need to take entire days of rest.

With relevant data, we may be able to use a real time data analysis to predict when Alanna is experiencing fatigue in order for preventative measures to be taken.

The physical conditions that Alanna lives with include fibromyalgia (FM), lymphedema, and spondylarthritis. Each of cause a variety of symptoms, though they all cause pain in some respect.

The severity of FM symptoms tends to fluctuate significantly, where periods of acute symptoms are commonly known as "flare ups" [1]. The duration of these flare ups ranges from a few hours to a couple of months depending on the cause of the flare up [2]. Symptoms of FM include extreme fatigue as well as muscle spasms [3] (both referred to by client). The underlying causes of FM flare ups are not well known [4], though it is often linked to any kind of stress, whether physical or psychological [4], [5]. For example, symptoms may be caused by either overexertion or a change in schedule [5].

Lymphedema is a condition which is often caused by cancer surgery that causes swelling in tissues as a result of excess lymphatic fluid [6]. Though this disease is uncurable [7], the Canadian Cancer Society puts heavy emphasis on avoiding any damage to the skin as to prevent worsening symptoms [6].

Surface electromyography (sEMG) sensors have previously been used with athletes as to predict fatigue [8]. sEMG sensors measure electrical pulses caused by muscle stimulation and require direct skin contact [9]. With proper data analysis, this method showed promising results with error approximates less than 5% [8].

As previously mentioned, muscle spasms are one of the common symptoms that are associated with FM. Our client has stated that she often senses this in her hands. Measurement of hand tremor has previously been done with the use of an accelerometer and gyroscope [10]. This system was used to allow doctors to remotely monitor clients who experienced hand tremors [10].

With two possible means of predicting flare ups, further analysis must be done to determine the optimal method.

As Alanna has mentioned, while a particular solution may aid in dissolving issues caused by one of her conditions, it may give rise to new symptoms caused by a different condition. Given the complications associated with lymphedema, avoiding skin contact with harsh surfaces is of great

importance. For this reason, the use of an accelerometer and gyroscope to achieve our goal may be preferable over the use of an sEMG sensor which requires a probe be in direct contact with the skin. The accelerometer and gyroscope data will give insight on Alanna's hand spasms which could be used to predict and prevent FM flare ups.

List of sources:

[1] "Fibromyalgia Flares: Symptoms, Triggers and Treatment - Living With Arthritis." http://blog.arthritis.org/living-with-arthritis/symptoms-fibromyalgia-triggers-treatment/ [Accessed Mar. 14, 2021].

[2] "How Long Will a Fibromyalgia Flare Last? | Causes of Fibromyalgia Flares." https://ocspinecenters.com/how-long-does-a-fibromyalgia-flare-last/ [Accessed Mar. 14, 2021].

[3] "Fibromyalgia flares: Warning signs, tips, and treatments." https://www.medicalnewstoday.com/articles/315646#what-is-a-fibromyalgia-flareup [Accessed Mar. 14, 2021].

[4] "What is known about the causes of fibromyalgia?," Mar. 2018, Accessed: Mar. 14, 2021. [Online]. Available: https://www.ncbi.nlm.nih.gov/books/NBK492983/.

[5] "What Causes Fibromyalgia to Flare Up? Top 10 Causes." https://www.draperchirosource.com/what-causes-fibromyalgia-to-flare-up-top-10-causes/ [Accessed Mar. 14, 2021].

[6] "Lymphedema - Canadian Cancer Society." https://www.cancer.ca/en/cancer-information/diagnosis-and-treatment/managing-side-effects/lymphedema/?region=on [Accessed Mar. 14, 2021].

[7] "Lymphedema - Diagnosis and treatment - Mayo Clinic." https://www.mayoclinic.org/diseases-conditions/lymphedema/diagnosis-treatment/drc-20374687 [Accessed Mar. 14, 2021].

[8] M. R. Al-Mulla, F. Sepulveda, and M. Colley, "An autonomous wearable system for predicting and detecting localised muscle fatigue," Sensors, vol. 11, no. 2, pp. 1542–1557, Feb. 2011, doi: 10.3390/s110201542.

[9] "What is EMG sensor, Myoware and How to use with Arduino? - Latest open tech from seeed studio." https://www.seeedstudio.com/blog/2019/12/27/what-is-emg-sensor-myoware-and-how-to-use-with-arduino/ [Accessed Mar. 14, 2021].

[10] N. Prakash, "Measurement and Analysis of Hand Tremor Using Iot," 2019. [Online]. [Accessed: Mar. 14, 2021].

*If you are in a team of 5, please copy and paste the above on a new page.

MILESTONE 2.3 – REFINED PROBLEM STATEMENT

Team Number: Thurs-07

1. Write your initial problem statement below. This is what you have submitted for Milestone 1.2.

Design a solution to enable Alanna to maintain physical movement for longer periods of time, as her fibromyalgia and spondyloarthritis make it difficult to bear weight or remain in one position for extended periods.

2. Outline the Who, Where, Why, and What elements of your problem statement. Then write the refined problem statement below. Refer to the provided Refined Problem Statement rubric provided.

- Who? – Alanna
- Where? – For use anywhere around her household
- Why? – To reduce pain and the need to take entire days of rest, while allowing her to take part in the activities that she enjoys
- What? – A device that predicts and prevents fibromyalgia flare ups

Refined Problem Statement:

Design a device that Alanna can use around her house to perform various activities with more comfort, that may predict fibromyalgia flare ups and alert Alanna so she can avoid injuring herself and avoid requiring entire days of rest.

MILESTONE 2.4 – FUNCTIONAL ANALYSIS

Team Number: Thurs-07

1. Identify your team's choice of design tool to perform Functional Analysis and the rationale behind choosing it. For examples of design tools, see "Review of Design Process" lecture – Wednesday, Feb 24th.

Choice: Morph chart

Rational: A morph chart assists in isolating the important functions of the proposed solution, which then allows multiple different means to be created to accomplish those specific functions. This helps diversify the possibly designs that are being considered.

2. Include a copy of your team's functional analysis below.

	Mean 1	Mean 2	Mean 3	Mean 4	Mean 5
Predict Pain	Machine Learning Model	Predetermined threshold values	Compare sensor data to known fatigue patterns (ex. twitching, shaking)	User input of when she begins to feel fatigue and record amount of time to use for future predicting	Facial expression analysis
Allow comfortable handling	Wide "paddle" grip, similar to her wide paint brush	Soft materials like sponge used in the model to make sure it is comfortable to hold	Memory foam that adapts to her preferred grip	Device is supported by the forearm, rather than held by the hand	Device is mounted to the wall via an articulating robotic arm
Detect fatigue and/or stress	Movement sensors integrated into a handheld device (accelerometer / gyroscope)	sEMG sensors on muscles	Array of external cameras in the room that analyze Alanna's motion	Brain-wave detection (maybe a helmet) to read stress levels	Detect change in grip force on device using piezoelectric force sensor on handle
Hold onto various paintbrushes	Accept any generic brush handle with an adaptive friction fit	A standard physical interface on each paint brush that is accepted by the device	Magnetic connection	A screw on system	A rotating tool exchange system
Display data	Display live statistical data using a chart based on sensor readings periodically	Display different messages on what to do depending on the sensor values	3D visualization of the device on screen	Store the data in a database for future reports which can be later presented in the form of a table	Phone app
Alert Alanna	Audio signal like a buzzer or speaker	Flashing LEDs, colored to indicate warning level	Device ejects the tool in use to prevent Alanna from using it more	Visual display with a description of the warning	Device vibrates

Objectives:

Must be very lightweight

Should feel natural to use

Should appear unappealing for children to play with (so it does not get "weaponized")

Should not aggravate any other symptoms during usage

MILESTONE 2.5 – CONCEPT EXPLORATION

Team Number: Thurs-07

Complete this worksheet during Design Studio/Lab B for Week 8.

1. Include multiple photos of your concept exploration, if needed
   → Include necessary annotations to help in the communication of your ideas
   → Include your Team Number, Name and MacID on *each* concept
2. Insert your photo(s) as a Picture (Insert > Picture > This Device)
3. **Do not include more than *two* concept photos per page**

Make sure to include photos of each team member's concept exploration

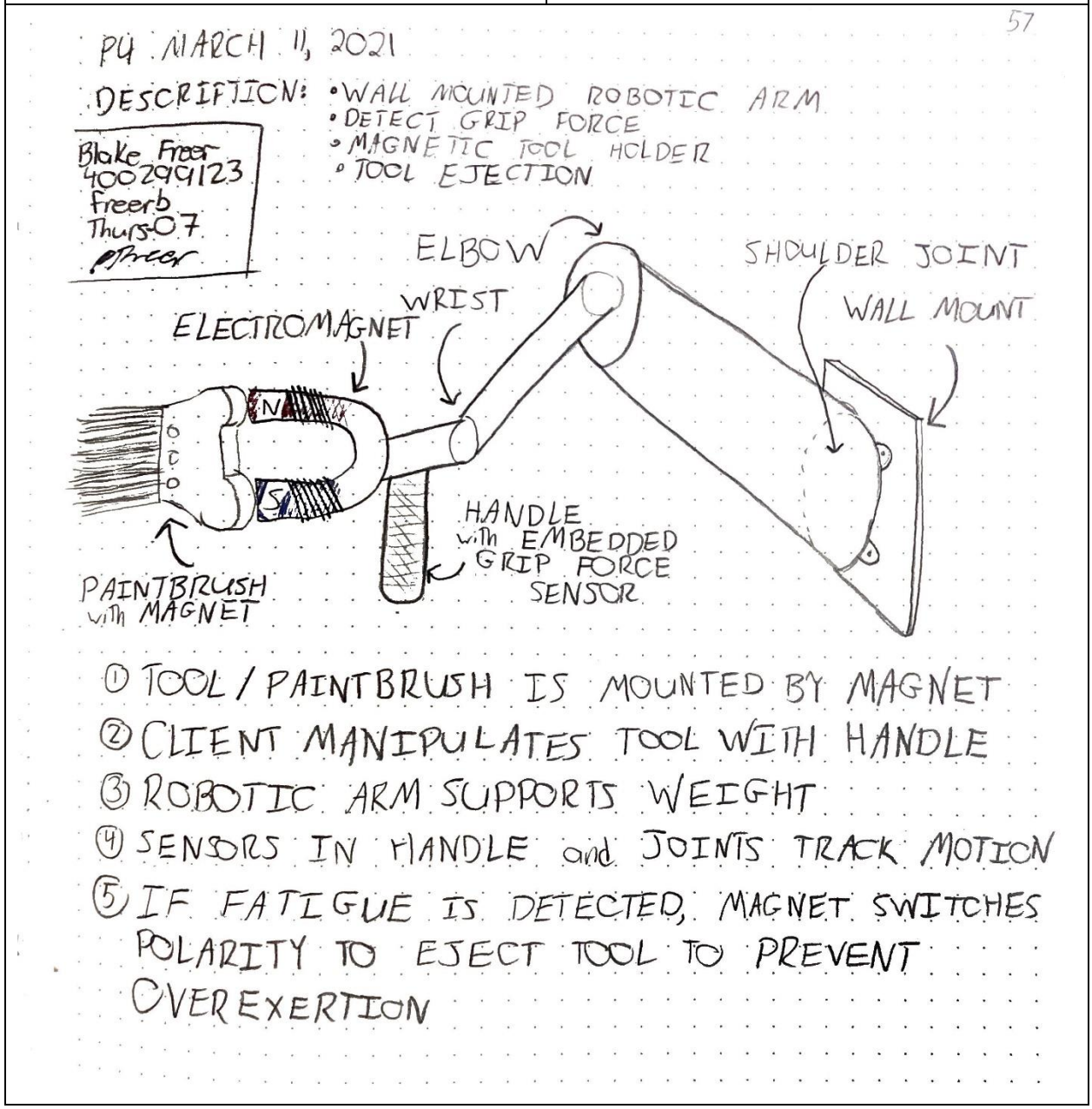
We are asking that you submit your work on both the team and individual worksheets. It does seem redundant, but there are valid reasons for this:

- Each team member needs to submit pictures of their concept with the **Milestone Two Individual Worksheets** document so that it can be ***graded***
- Compiling your individual work into this **Milestone Two Team Worksheets** document allows you to readily access your team member's work
  - This will be especially helpful when completing the next milestone

Team Number: Thurs-07

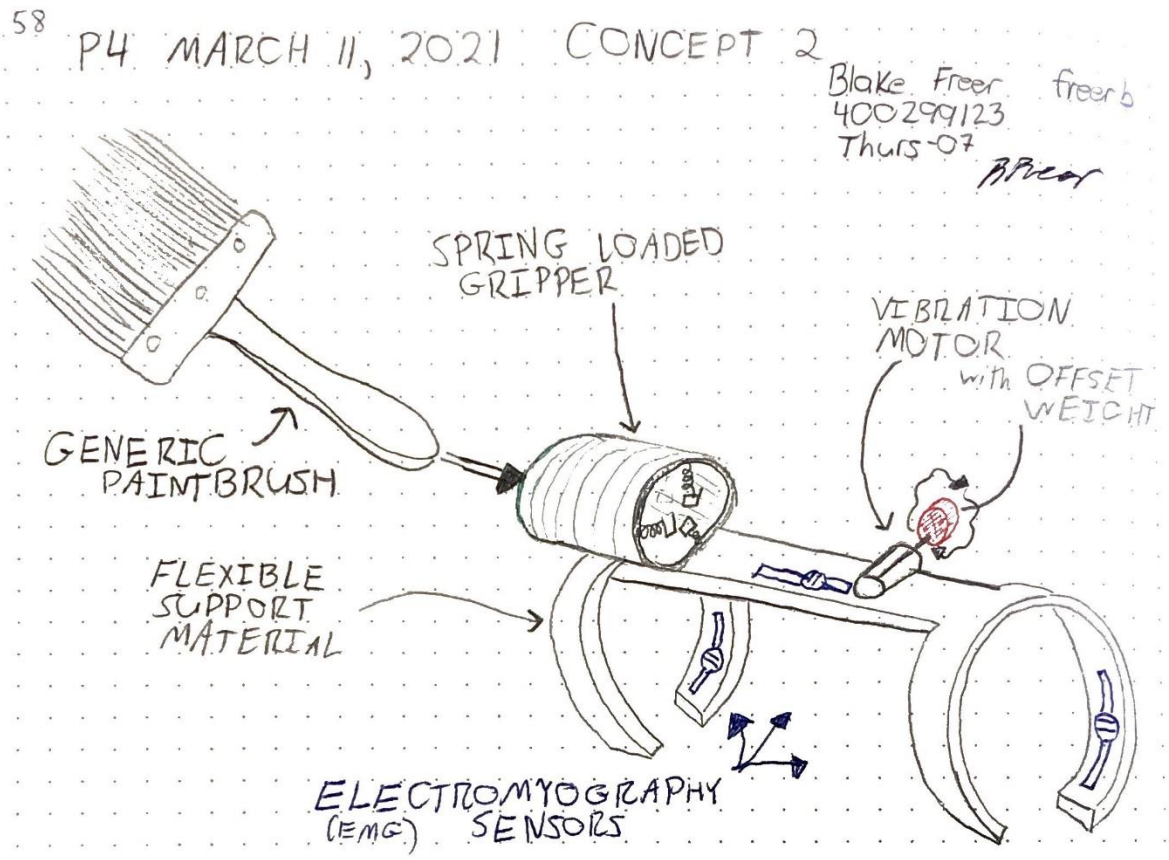
Concept 1

Name: Blake Freer	MacID: freerb



Concept 2

Name: Blake Freer	MacID: freerb

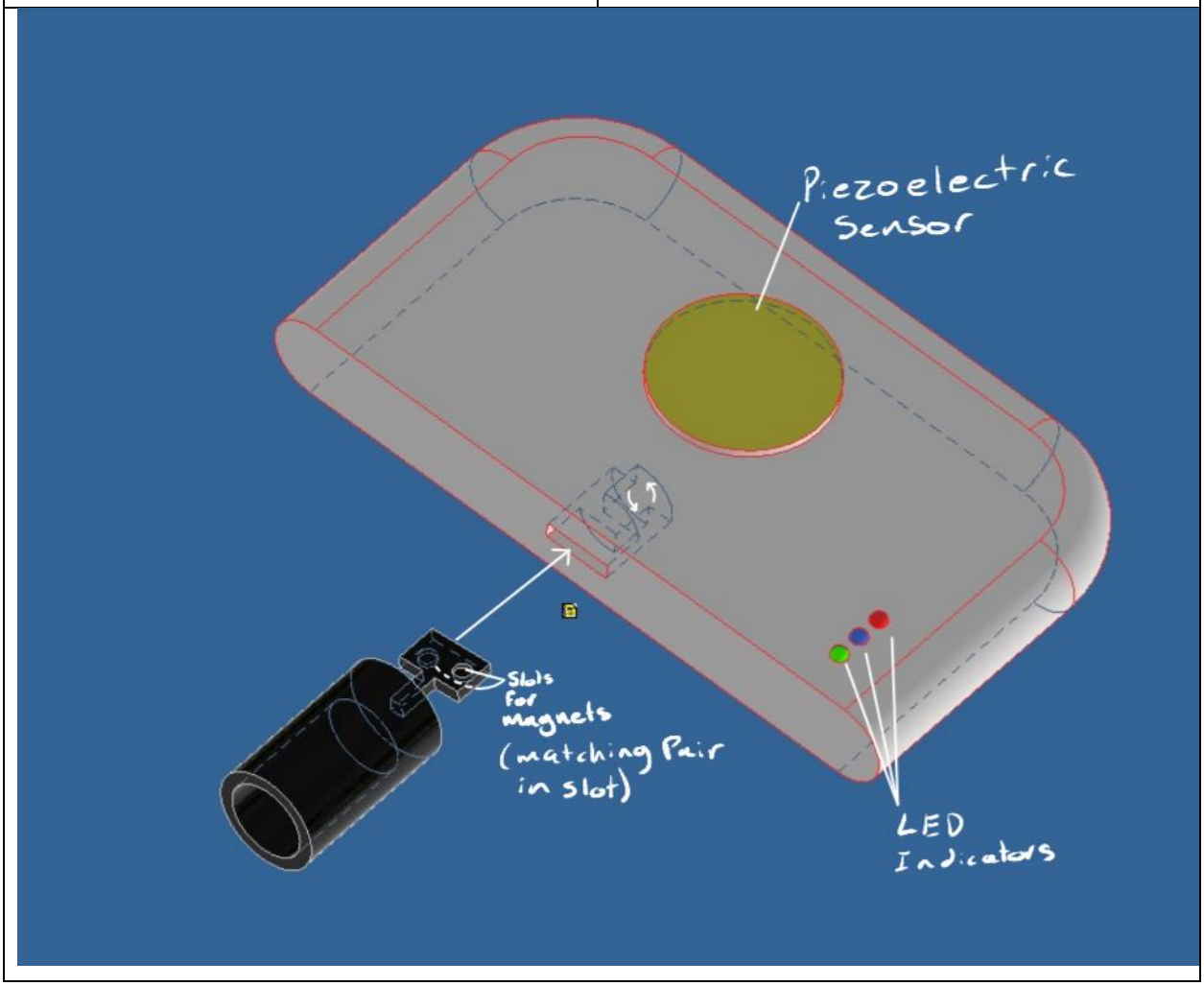


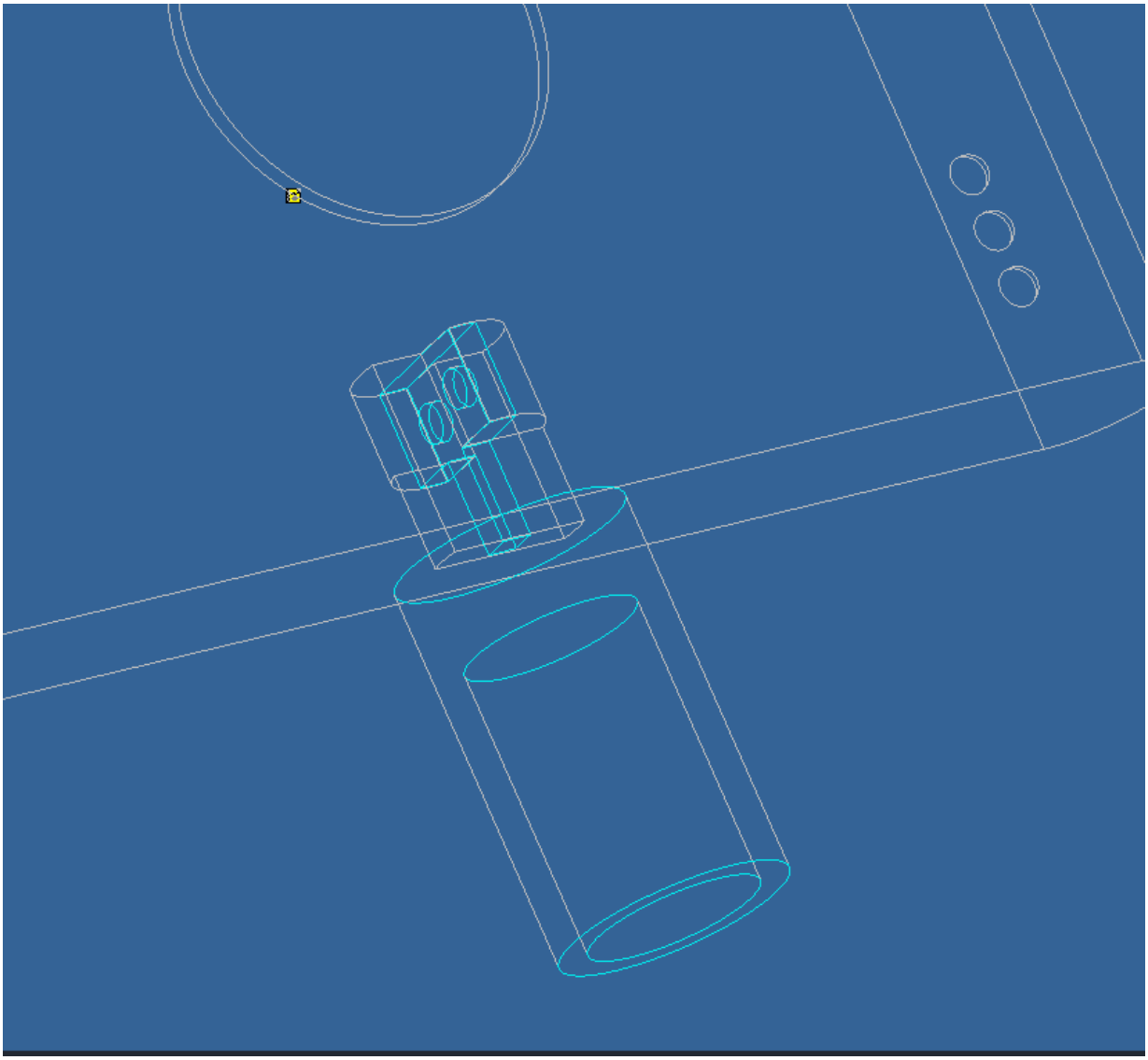
1. CLIENT INSERTS WRIST INTO DEVICE
2. PAINTBRUSH MOUNTED in GRIPPER
3. EMG Sensors TRACK MUSCLE USAGE
4. IF FATIGUE is DETECTED, VIBRATION MOTOR ALERTS CLIENT

Team Number: Thurs-07

Concept 1

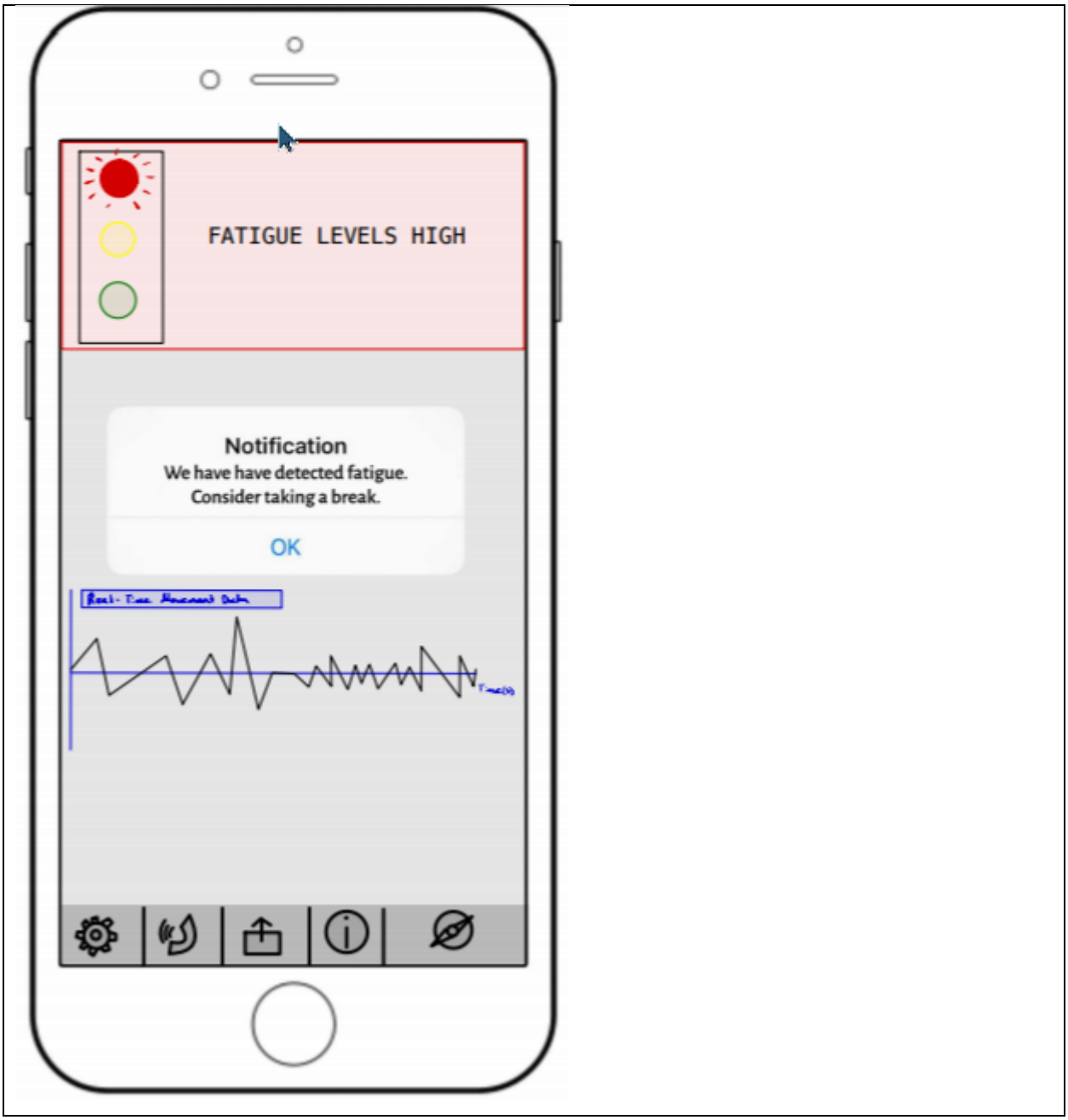
Name: Samuel Parent	MacID: Parens4





Concept 2

Name: Samuel Parent	MacID: Parens4
Insert screenshot(s) of your concept below.	

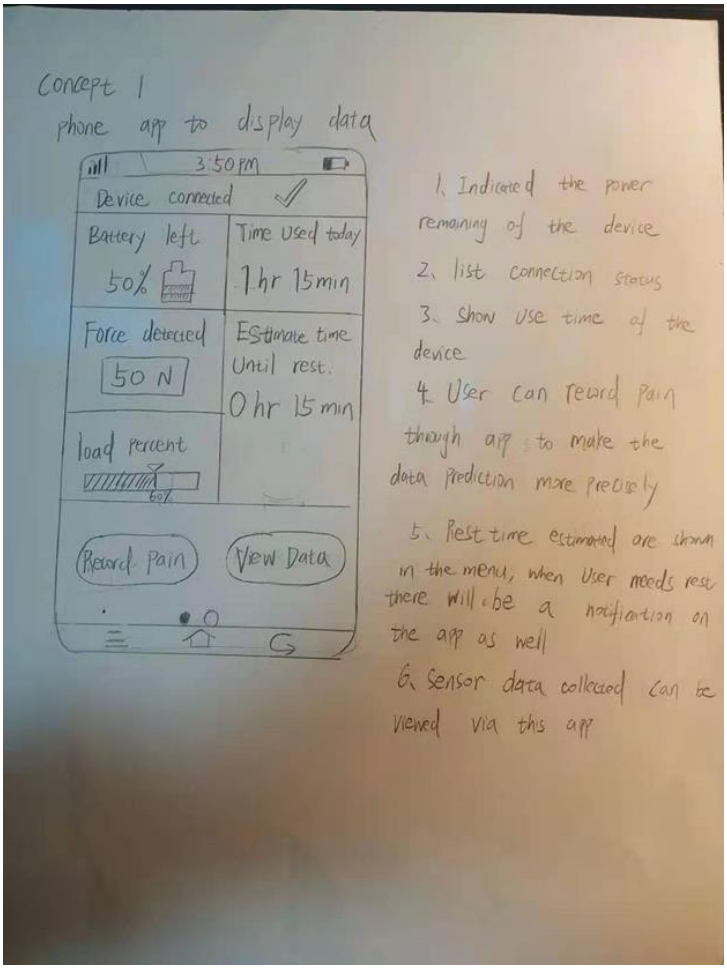

FATIGUE LEVELS HIGH
Notification
We have have detected fatigue.
Consider taking a break.
OK

Team Number: Thurs-07

Concept 1

Name: Dehe Meng	MacID: mengd9

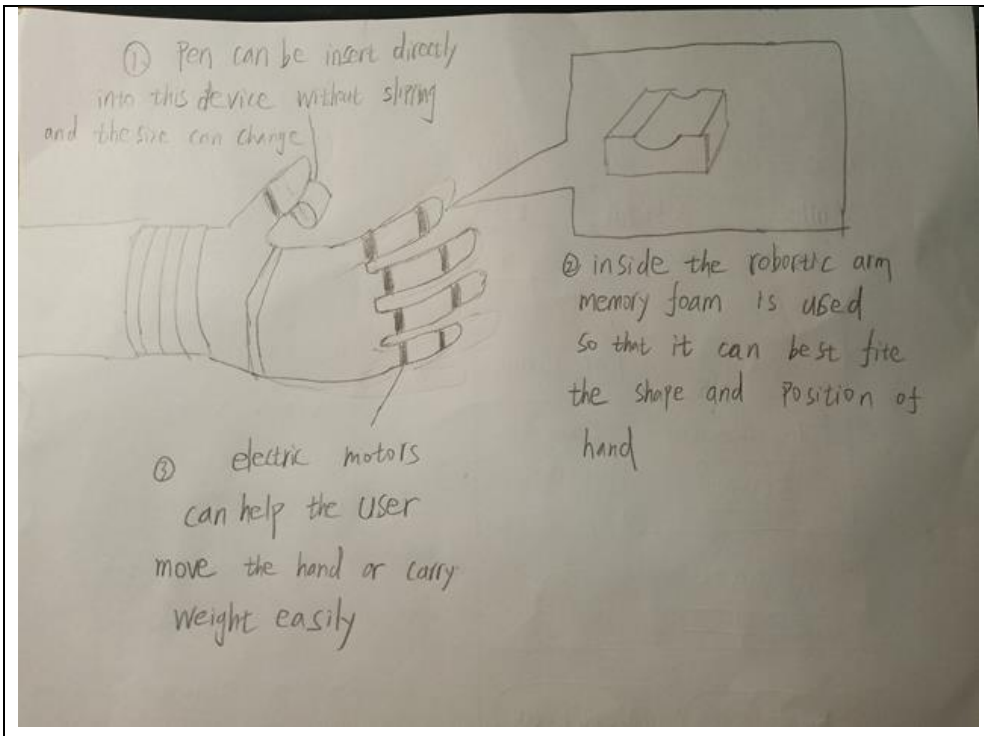
Insert screenshot(s) of your concept below.



Concept 2

Name: Dehe Meng	MacID: mengd9

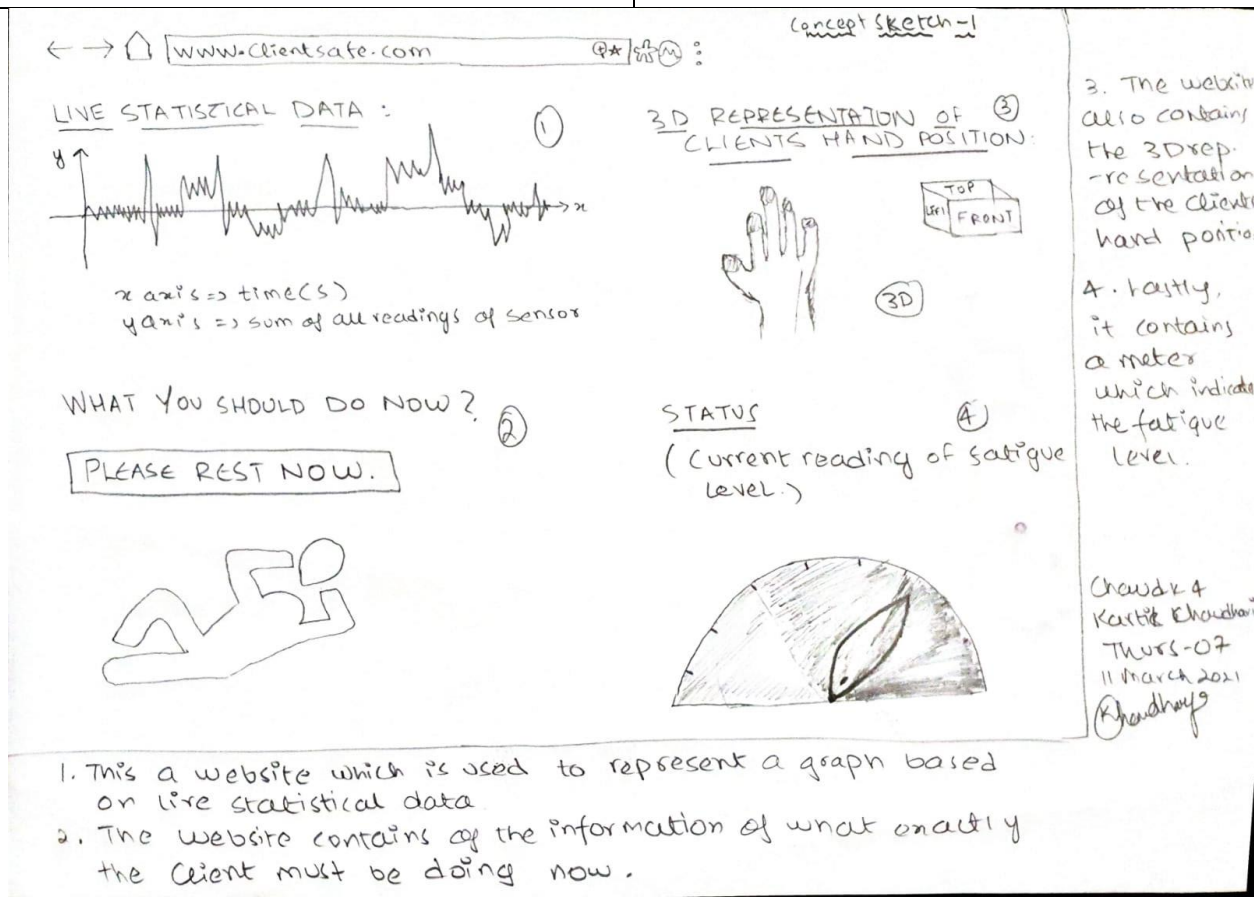
Insert screenshot(s) of your concept below.


① Pen can be insert directly into this device without slipping and the size can change
② inside the robotic arm memory foam is used so that it can best fite the shape and position of hand
③ electric motors can help the user move the hand or carry weight easily

Team Number: Thurs-07

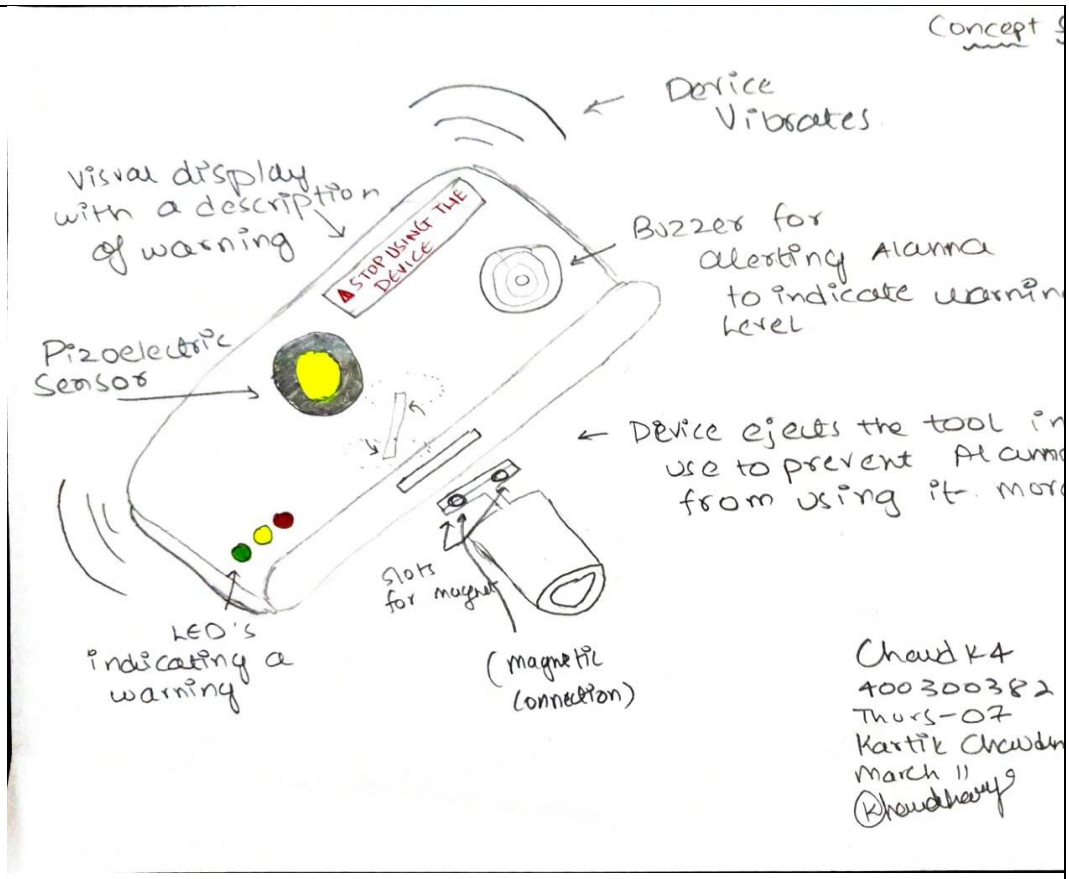
Concept 1

Name: Kartik Chaudhari	MacID: chaudk4



Concept 2

Name: Kartik Chaudhari	MacID: chaudk4


Concept
Device Vibrates
Visual display with a description of warning
STOP USING THE DEVICE
Buzzer for alerting Alarm to indicate warnin level
Pizoelectric Sensor
Device ejects the tool in use to prevent Alarm from using it mor
Slots for magnet
LED's indicating a warning
(magnetic connection)
Chand K4
400300382
Thurs-07
Kartik Chowdh
March 11
Khowdhary