

PROJECT FOUR: MILESTONE 2 – COVER PAGE

Team Number: Tues-26

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

Full Name:	MacID:
Jackson Lippert	lippertj
Borna Sadeghi	sadegb1
Ahmed Mohamed	mohaa97
Andrew Krynski	krynskia

## MILESTONE 2.1 – CLIENT NOTES

Team Number: Tues-26

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.

- She is 5'1.5"
- Her working area is about 4 feet by 7 feet.
- Uses spinal flexibility daily (e.g. to pick things up)
- Affected by extreme temperatures
- Uses angled brushes, enjoys precision brushes
- Uses handle-less brushes to use her whole hand, as it is more gentle on the hands
- Brush size is more of a problem than the brush weight
- Also does gardening
  - Bending over to maintain weeds is the most difficult part
- Doesn't do digital art
- 20-30mm of compression recommended for her
- Has to move constantly, staying still leads to problems and she must listen to her body
- Keeps cane at the top of staircase, step stool in washroom
- Velcro shouldn't be against her skin
- Her big painting is 39.5" by 39.5"
- The colder it is, the worse her pain is
  - Heat better than cold, but no extreme temperatures
- Before pandemic, running errands was difficult
  - Doesn't drive anymore
- Dealt with a lot of ableism, e.g. at grocery store, public transit
- Wants to take control of things that she would usually be responsible for
- No glutenous materials (e.g. paper mache)
- No rough materials
  - Cotton and silk are good for protection
- Wouldn't have painted on the floor if it wasn't for the pain
- Lives with nausea and dizziness, being on the floor stabilizes this and increases focus
- Arm gets tired before body when painting
- Exercises with ankle weights; leg lifts, leg fluttering, core strengthening exercises
- Pushing is easier than pulling because she can put her torso weight on the object
- Shoulder strap will most likely not work due to where lymphedema is
- Compression gear is kind of like very thick tights (nylon, spandex, etc.) like a bra from a 1970s movie?
- The more she can use her palm of her hand, the easier

## MILESTONE 2.2 – RESEARCH ASSIGNMENT

Team Number: 

Tues-26
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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: **Tues-26**

Name: Jackson Lippert	MacID: lippertj
<p>How can dexterity be improved/ hand pain be eased?</p> <p>Hands are a very complex system of muscles, bones, tendons, and nerves which all work together to allow humans to perform fine motor movements. As such, there are many reasons for people to have difficulty with dexterity. For many people, improving dexterity is as simple as stretching your hands/wrists daily, exercising them, and giving them relief to recover [1]. However, people who experience pain in their hands from conditions such as arthritis and fibromyalgia make tasks using grip very difficult [2]. A lot of this pain is caused by inflammation of the tendons and joints, which causes the joints to cease up and become stiff. The nerves in the hand and through the carpal tunnel may also be pinched by the inflammation, causing pain throughout the hand [3]. Pain, in general, is the brain's way of telling the body to stop what it is doing to ease the pain. This makes daily tasks that use any sort of dexterity extremely difficult when your brain is telling you to stop the whole time. To combat this, there are a few main ways to help ease muscle and joint pain in the hands: stretching, hot/cold, splints, and reduced stress. Stretching your muscles and joints is a great way to promote healthy circulation through the hands, which may help to reduce inflammatory pain [4]. Another proven method which helps reduce inflammation is applying heat and cold to the hands. Heat will help to loosen up joints, which will make movements easier, and cold will help to immediately reduce inflammation [4]. Splints help by letting the fingers rest idle without any force, which, when used in moderation, gives the inflammation time to settle down. Finally, reducing the amount of stress that gets applied on one's joints reduces the likelihood of a flare up of inflammation, easing the pain one feels. Taking all treatment methods into account, it becomes evident that people who experience hand pain just want to carry on with their daily lives without inhibition. I think that applying this avenue of thought to the project will help with developing a possible product which helps ease our client's hand pains. In summary, there are many proven methods to reduce hand pain which may be integrated into our project.</p> <p>[1] Leonard Kim, "5 Hand Exercises to Help You Maintain Your Dexterity &amp; Flexibility," University of Southern California, (online). Available: <a href="https://uscvhh.org/news-and-stories/5-hand-exercises-to-help-you-maintain-your-dexterity-flexibility.html">https://uscvhh.org/news-and-stories/5-hand-exercises-to-help-you-maintain-your-dexterity-flexibility.html</a>. [Accessed: March 8, 2021].</p> <p>[2] Kristeen Cherney, "Everything You Need to Know About Fibromyalgia," Healthline, 2020, (online). Available: <a href="https://www.healthline.com/health/fibromyalgia">https://www.healthline.com/health/fibromyalgia</a>. [Accessed: March 8, 2021].</p> <p>[3] "Hand and Wrist Pain," Versus Arthritis, (online). Available: <a href="https://www.versusarthritis.org/about-arthritis/conditions/hand-and-wrist-pain/">https://www.versusarthritis.org/about-arthritis/conditions/hand-and-wrist-pain/</a>. [Accessed: March 8, 2021].</p> <p>[4] "Top 5 Ways to Reduce Crippling Hand Pain," Harvard Health Publishing, 2020, (online). Available: <a href="https://www.health.harvard.edu/pain/top-5-ways-to-reduce-crippling-hand-pain">https://www.health.harvard.edu/pain/top-5-ways-to-reduce-crippling-hand-pain</a>. [Accessed: March 8, 2021].</p>	

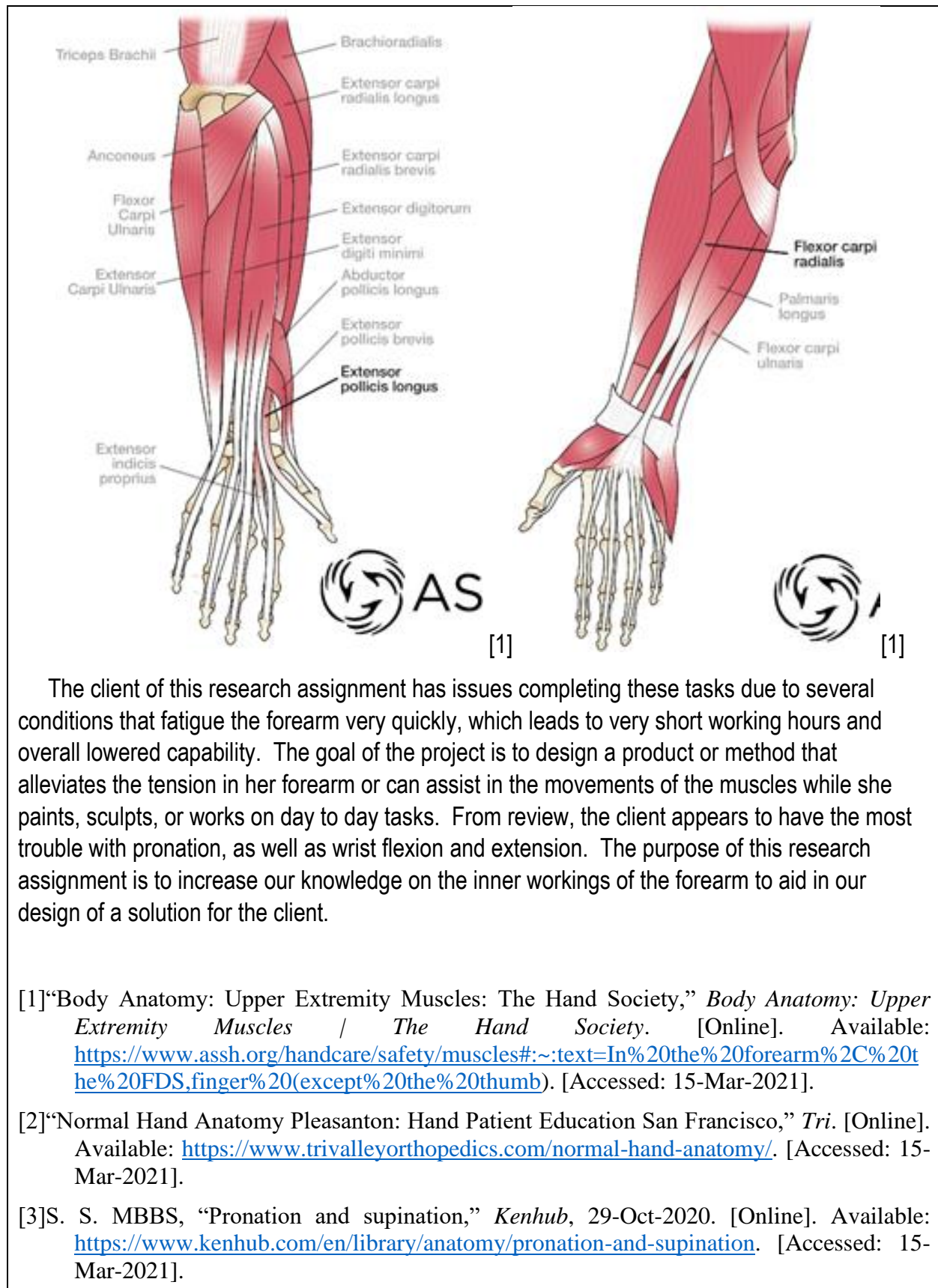
Team Number: 

Tues-26
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Name: Andrew Krynski	MacID: krynskia
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How do the muscles in the forearm control the hand and wrist joint?

The human hand is not actually controlled by muscles within it, but with connective tissue controlled by the forearm. The forearm is made up of twenty different muscles working together to perform several functions of the hand [1]. There are several movements that these twenty muscles control, this document is focused on the major functions of the wrist movement. The wrist movement is broken down into 4 mechanisms: flexion, extension, adduction, and abduction. Wrist flexion is the movement of the palm of the hand towards the front of the forearm [2], and utilizes mainly the carpi ulnaris, carpi radialis, and assisted by the digitorum superficialis [4]. Extension is the opposite of flexion and is the movement of moving the back of hand towards the back of the forearm [2]. Extension of the wrist uses the capri radialis longus, capri radialis brevis, capri ulnaris, with assistance from the digitorum [4]. The other two operations performed by the wrist are also opposites: adduction and abduction. Adduction is the movement of moving the pinky side of the hand towards the outer of the forearm [2] and is controlled by the carpi ulnaris [4]. Abduction on the other hand is the movement of the thumb side of the hand towards the inner of the forearm [2], and is controlled with the pollicis longus, carpi radialis, carpi radialis longus and carpi radials brevis [4]. The other major movements that appear to the wrist are pronation and supination. While these movements utilize the forearm as well, they are also controlled by muscles in the upper arm. Pronation is the rotation of the palm downwards, and utilizes the teres and quadratus muscles, as well as being assisted by the brachioradialis [3]. Supination does the opposite, and is the rotation of the palm upwards, utilizing the supinator muscle and the biceps brachii [3].



## ENGINEER 1P13 – Project Four: *Power in Community*

[4]“The Wrist Joint,” *TeachMeAnatomy*. [Online]. Available: <https://teachmeanatomy.info/upper-limb/joints/wrist-joint/>. [Accessed: 15-Mar-2021].

Team Number: **Tues-26**

Name: Ahmed Mohamed

MacID: mohaa97

**What is the common cause of the clients health issues?**

It is obvious from the patient's previous work as a midwife and her current interest in painting that she possesses fine motor skills in her hands, which would be affected by her current conditions. Since hand motor skills are the most specific and controlled in the body, it would have to be the most densely innervated, because movement and muscle contraction relies on nerves. Spondylitis is a condition which causes the spinal vertebrae to become inflamed and remove the protective cartilage between vertebrae to degrade causing the vertebrae to pinch the nerves [1]. This leads to compromised conduction of synapses and pain. Moreover, another condition she has is fibromyalgia which is a condition that causes pain and stiffness of muscle fibers due to the intramuscular inflammation, also making it hard to use her hands to perform the fine and specific movements that painting calls for. Another condition she suffers from is lymphedema which is a generalized swelling of the lymph nodes which can also cause pinched nerves especially in the axilla, which contains the brachial plexus which gives of all the muscles of the hand, so a swelling in the area could greatly comprise movement and cause pain[2].

It is clear that all her conditions are directly linked to inflammation, so she should look at ways of relieving inflammation. NSAIDS are a good way to relieve sever and sharp episodes of inflammation but are not made for long term use. Organic foods such as cherries, broccoli, and walnuts, have been deemed to be great ways to bring down inflammation and have great nutritional value [3]. Meditation is also a proven way to relieve inflammation[4], and painting could be considered a kind of meditation, which could be a reason for why she feels comfort when she paints. However, to get better results she should switch from acrylic based paints to oil-based paints for the toxic fumes that come from acrylic colors.

[1] Michelle Petri, Pregnancy and Rheumatic Disease Clinics of North America, Vol.33, No. 2) (Rheumatic Disease ,2007. [E-book] Available: <https://www.amazon.com/Pregnancy-Rheumatic-Disease-Clinics-America/dp/1416043667>.

[2] S. Klonisch, Sobotta Clinical Atlas of Human Anatomy, one volume, English, 2019.

[3] J. Raymond, K. Morrow, Krause and Mahan's Food and the Nutrition Care Process E-Book (15th ed.), 2020. [E-book] Available: [https://www.ebooks.com/en-sa/book/210014656/krause-and-mahan-s-food-and-the-nutrition-care-process-e-book/raymond-janice-l-morrow-kelly/?src=feed&qclid=Cj0KCQjwi7yCBhDJARIsAMWFScNY9RCWZOI Izi7Jl3pUJXUnFrsQf 2MracSQ9vS-5XiRu8OGBQZNlaAhkqEALw\\_wcB](https://www.ebooks.com/en-sa/book/210014656/krause-and-mahan-s-food-and-the-nutrition-care-process-e-book/raymond-janice-l-morrow-kelly/?src=feed&qclid=Cj0KCQjwi7yCBhDJARIsAMWFScNY9RCWZOI Izi7Jl3pUJXUnFrsQf 2MracSQ9vS-5XiRu8OGBQZNlaAhkqEALw_wcB).

[4] S. Rea, "Neurobiological Changes Explain How Mindfulness Meditation Improves Health,".04, Feb, 2016. Available: <https://www.cmu.edu/news/stories/archives/2016/february/meditation-changes-brain.html>. [Accessed Mar. 15, 2021].



Team Number: Tues-26

Name: Borna Sadeghi

MacID: sadegb1

*Include your research assignment below.*

Research was performed on three of the major conditions that the client is afflicted with, spondylarthritis (ankylosing spondylitis), lymphedema as a result of breast cancer, and fibromyalgia. Due to ankylosing spondylitis affecting the client's sacroiliac joints, she may be experiencing fusion of her vertebrae. The symptoms that can appear as a result include lower back pain (experienced in most cases), fatigue, and stiffness, which can be either continuous or intermittent [1]. As the inflammatory pain symptoms tend to improve with activity (and the client reports more pain in the morning and when stationary for long periods of time), frequent exercise is essential for her to maintain her joint and heart health [2].

The client also reportedly suffers from fibromyalgia, a connective and soft tissue disease, with potential symptoms such as chronic, spontaneous, widespread severe musculoskeletal pain, stiffness and tenderness, fatigue and brain fog, sleep disturbance, and in some cases, irritable bowel syndrome, migraines, tension headaches, and dizziness. The causes of fibromyalgia may vary, but may correspond to injury or trauma of the central nervous system, an infectious agent, or shifts in muscle/connective tissue metabolism. Short-term remedies include a variety of medications, and application of therapeutic massage and heat [3]. In regards to the client's dexterity and fine manual skills, studies suggest that fibromyalgia patients often exhibit an altered neuromuscular strategy in their arm, and the client does demonstrate this by altering her pen-holding technique (straightening her wrist, etc.). It was also observed that fibromyalgia may also lead to reductions in handgrip strength and bilateral deficits in fine motor control, highlighting the importance of considering dexterity when designing rehabilitation devices for the patient [4].

Lymphedema is a buildup of a fluid known as lymph, which typically carries foreign material and bacteria away from bodily tissues, and circulates infection-fighting cells such as white blood cells around the body. This results in swelling as the lymph accumulates in the soft tissues of a limb (most commonly the arm or leg). It is a chronic, lifelong condition, and rather common among breast cancer survivors like the client, perhaps as a result of breast cancer surgery, which can lead to surgical damage that interferes with lymph flow [5]. One effective short-term remedy for the swelling is compression therapy, which the client applies regularly [6].

[1] K. Huston., "Spondyloarthritis", *American College of Rheumatology* [Online]. Available: <https://www.rheumatology.org/I-Am-A/Patient-Caregiver/Diseases-Conditions/Spondyloarthritis>. [Accessed: March 11, 2021]

- [2] P. Mease, M.A. Khan. “Axial Spondyloarthritis”, *Elsevier*, 2019. Available: <https://ebookcentral.proquest.com/lib/mcmu/detail.action?docID=5720632>.
- [3] P. Moglia. “Fibromyalgia.” *Magill’s Medical Guide (Online Edition)*, 2019.
- [4] M. Pérez-de-Heredia-Torres, R. M. Martínez-Piédrola, M. Cigarán-Méndez, R. Ortega-Santiago, C. Fernández-de-las-Peñas. “Bilateral deficits in fine motor control ability and manual dexterity in women with fibromyalgia syndrome”. *Experimental Brain Research*, vol. 226, pp. 137–143. January. 2013. doi: <https://doi.org/10.1007/s00221-013-3417-4>
- [5] “Lymphedema”, *Harvard Health Publishing*. Dec. 2018.
- [6] K. Johansson, K. Ochalek, and S. Hayes, “Prevention of arm lymphedema through the use of compression sleeves following breast cancer: results from a targeted literature review,” *Physical Therapy Reviews*, vol. 25, no. 4, pp. 213–218, Jul. 2020.

\*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: **Tues-26**

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

The client’s life can be uncomfortable and unpredictable due to symptoms caused by various health challenges. These unpleasantities should be eased to improve the enjoyability and comfort of the client’s life.

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? – Alana, our client.

- Where? – Residential area(s)/ our client's home.
- Why? – Improve quality of life for our client.
- What? – Ease discomfort in hands/arms

Refined Problem Statement:

Our client Alana has expressed trouble in the form of pain, fatigue, and general discomfort in her arms and leading into her hands while in her place of residence. This affects her on a day-to-day basis in her home, and therefore is the most prominent issue that needs to be solved to improve quality of life for our client.

## MILESTONE 2.4 – FUNCTIONAL ANALYSIS

Team Number: **Tues-26**

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 lecture on Monday March 8<sup>th</sup>.

Choice: Morphological Chart

Rational: This is a very open-ended project, so it is necessary to explore many possible design solutions. As such, our group chose to use a morphological chart because it allowed us to consolidate many ideas into one place.

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

Functions	Means 1	Means 2	Means 3	Means 4
Improve muscular endurance (in the arms/hands)	Sling to support weight of arm	Arm rest	Compression gear	Cold/hot compresses

## ENGINEER 1P13 – Project Four: *Power in Community*

Make painting easier	Remote-controlled painting machine	Pedal-controlled painting mechanism	Rubberized support attaching to the top of the canvas/easel	Easier accessibility to paints (easy to open jars etc.)
Reduce pain associated with gripping	Application of heat/cold	Application of compression/therapeutic massage	Application of remedial creams/fluids	Grip strength exercises by crushing the grip strength tool.
Improve dexterity/accuracy of hand movements	Knuckle stabilizer	Allow hands to rest and preform simple exercises	Easier, wider, and heavier tools to grip	Wrist weights/ weighted glove

## MILESTONE 2.5 – CONCEPT EXPLORATION

Team Number: Tues-26

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

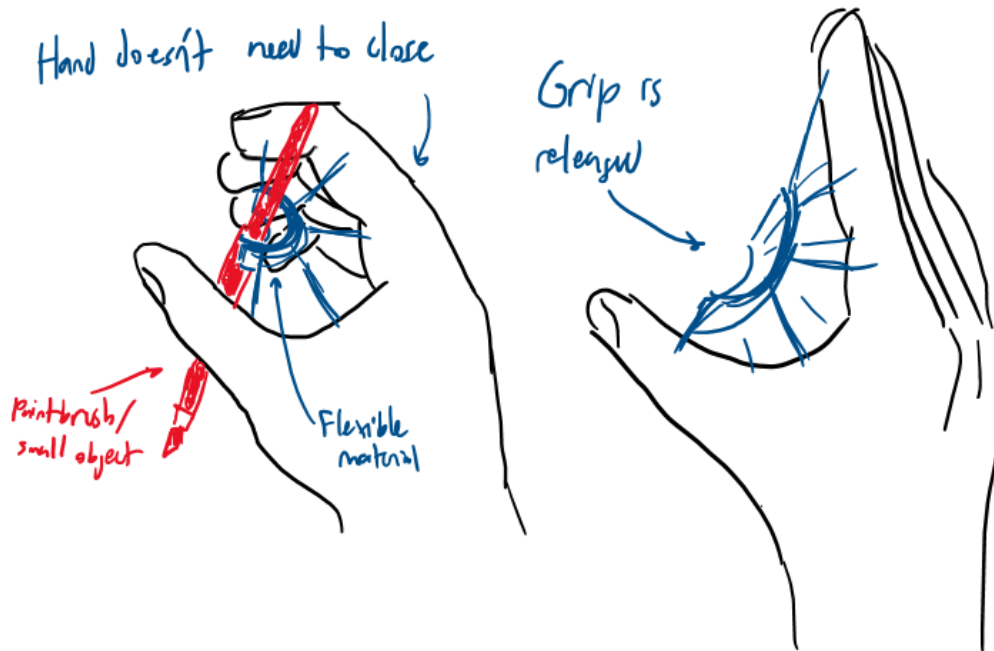
We are asking that you submit your work on both the team and individual worksheets. It does seem redundant, but there are valid reasons for this:

- 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: Tues-26**Concept 1**

Name: Borna Sadeghi

MacID: sadegb1

*Insert screenshot(s) of your concept below.**(Hand attachment/glove that makes gripping small things possible without closing the hand)*

- Jackson Lippert: Great idea and will definitely make gripping the paintbrushes/ any other small tools easier.
- Ahmed Mohamed: Amazing concept and will provide a wider grip which will make drawing easier
- Andrew Krynski: Great idea and will definitely help with gripping, my only concern would be about her hand cramping

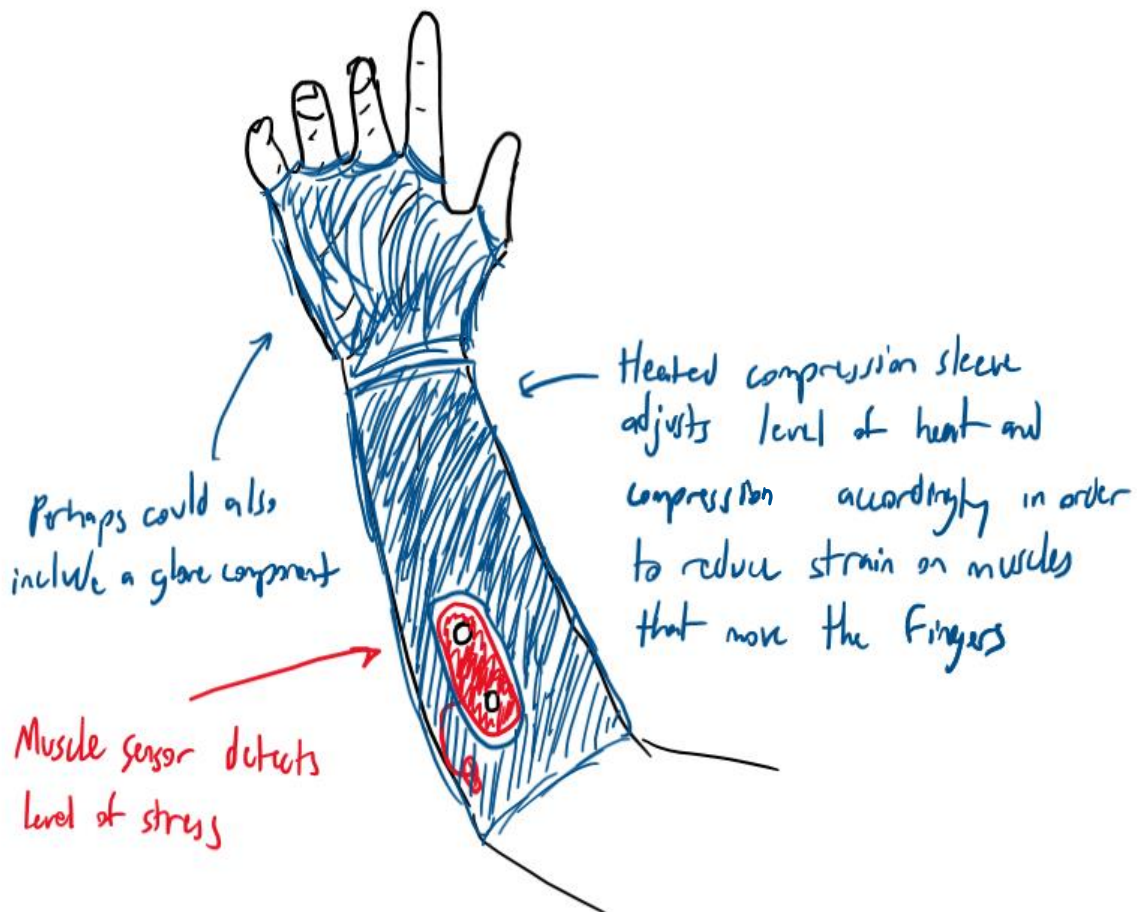
## Concept 2

Name: Borna Sadeghi

MacID: sadegb1

Insert screenshot(s) of your concept below.

(Muscle sensor detects stress in muscle and applies heat or pressure to ease pain)



- Jackson Lippert: I love the heated element of the design; it will help with her mobility in the forearm/hand. The only problem would be making sure it is not too harsh on the skin.
- Ahmed Mohamed: Simple and very useful concept. However, material should be picked wisely.
- Andrew Krynski: Simple and very feasible, material selection will have to be compatible with the client. Although, the heating element could be dangerous

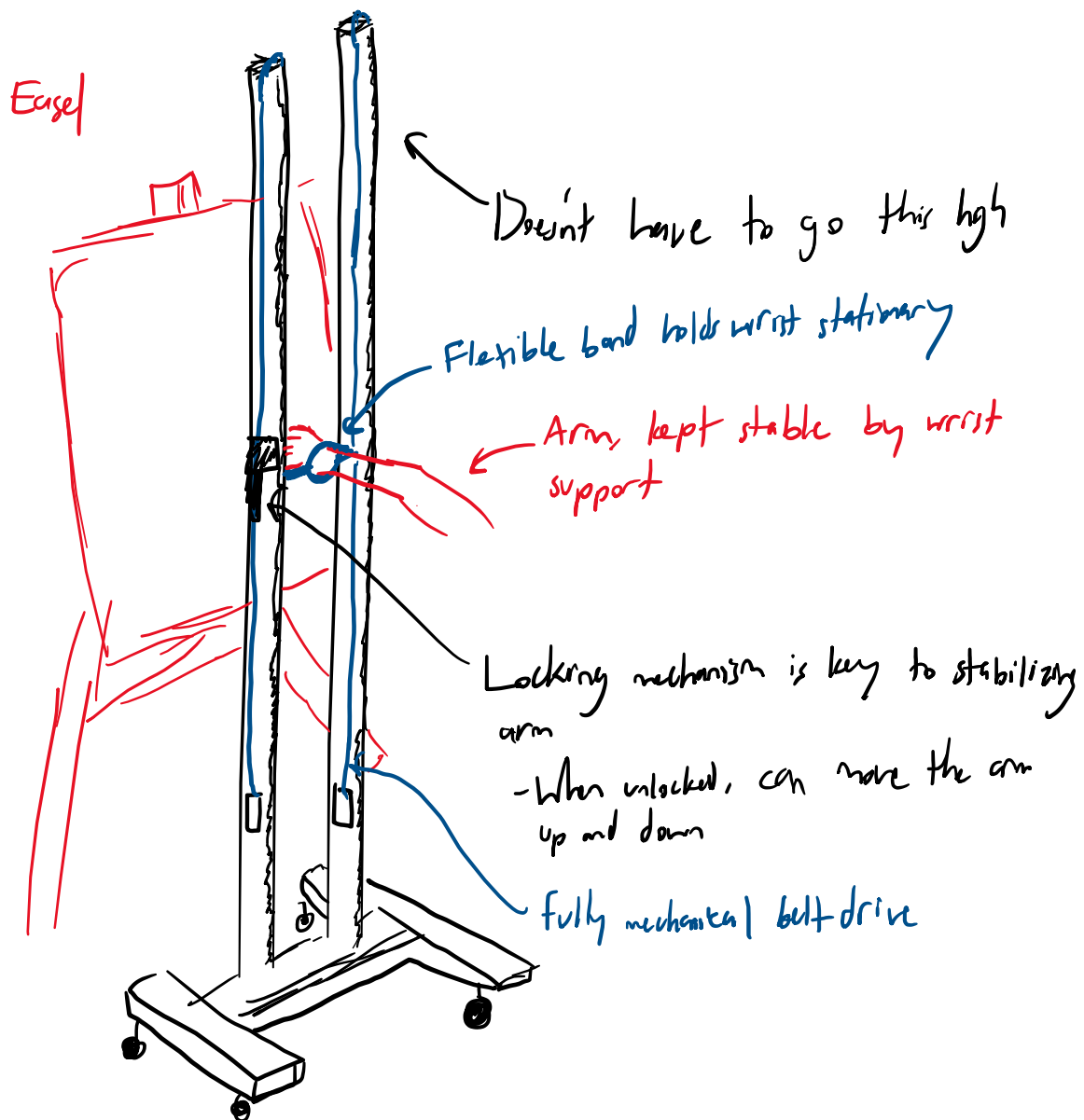
### Concept 3

Name: Borna Sadeghi

MacID: sadegb1

Insert screenshot(s) of your concept below.

(Wrist stabilization system with a lock, which can roll around the floor, and the wrist can lock in place whenever needed)





Team Number: **Tues-26****Concept 1**

Name: Ahmed Mohamed

MacID: mohaa97

Concept 1

Ahmed Mohamed  
mohaa97

**Main Model:**  
Supportive accessory for her hands to avoid any Pain while Painting.

**Wrist Support:**  
A flexible wrist support which is made with a soft material that will store the Pain relief fluid whilst keeping her arm stable and relieve of any wrist pain.

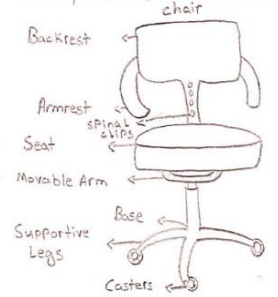
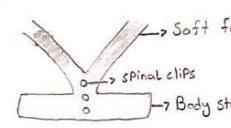
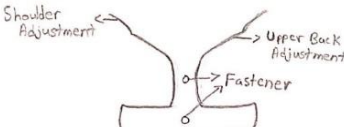
**Knuckle Support:**  
Soft layering around her Knuckles filled a Pain relief fluid to relax her knuckles so she can Paint with ease.

**Fluid Transfer Process:**  
The Spherical base will receive the Pain relief fluid from the wristband and with the help of the detection Sensor which will initiate a signal to the spherical base on how much fluid will be required to transfer to each Knuckle. Then the fluid tubes will transfer the required fluid to the Knuckle supports which will release it gradually allowing the Knuckles to absorb it.

Labels in diagrams:  
Flexible Wrist Support  
Fluid Storage  
Wrist band  
Spongy layered garment  
Detection Sensor  
Knuckle Support  
Fluid tubes  
Spherical base

- Jackson Lippert: This would definitely help our client's hands and lessen the pain, however the type and delivery of the fluid will have to take a lot of thought and consideration.
- Borna Sadeghi: Think about different ways to quantify the flow of the fluid to reduce mess (e.g. flow sensor). Also consider that she could simply apply the fluid to her hands by herself, which may be easier and more reliable than using this mechanism.
- Andrew Krynski: I like the idea of supporting her individual joints, however the fluid delivery system seems tedious and could also add a significant weight to her hand

## Concept 2

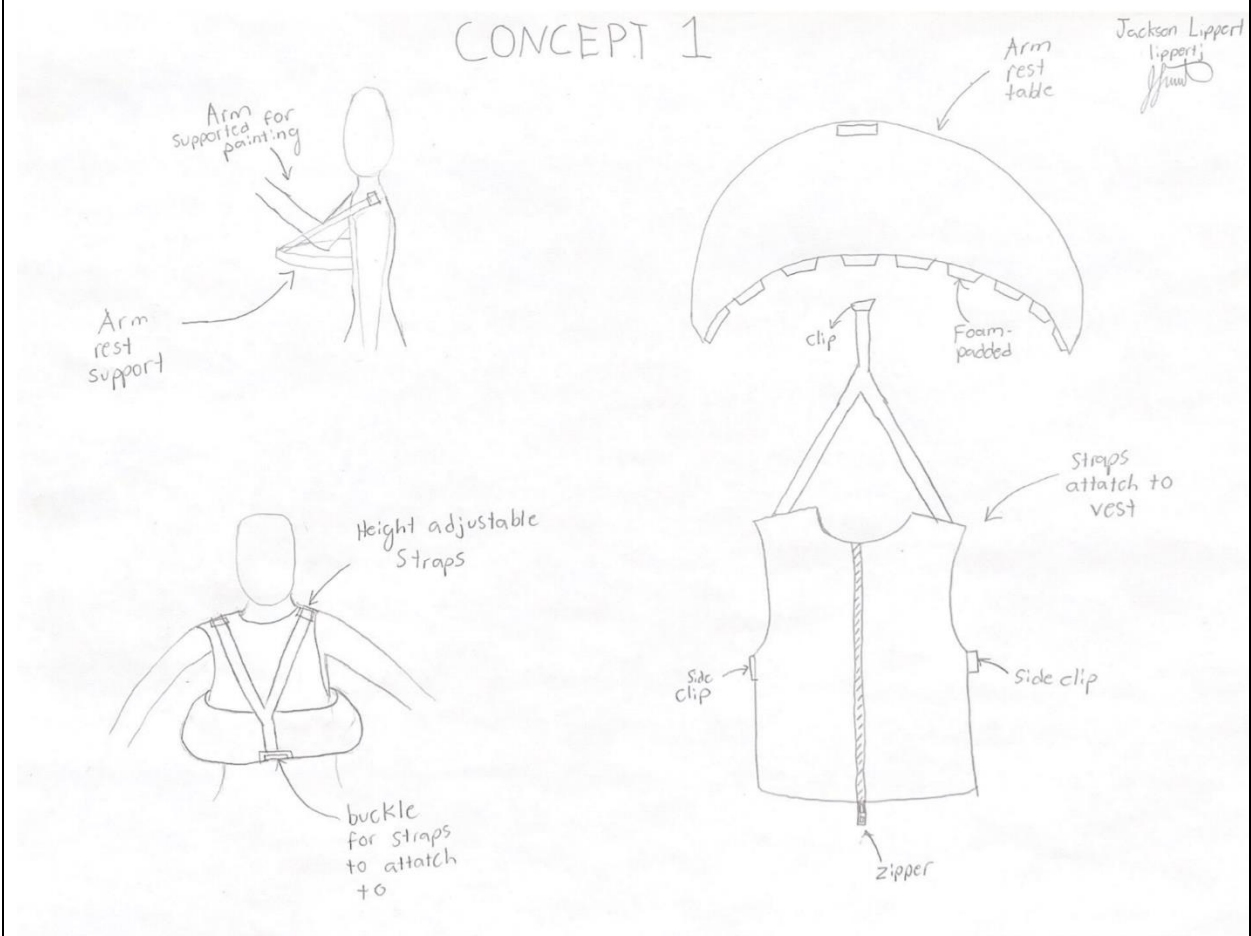
Name: Ahmed Mohamed	MacID: mohaa97
<p>Concept 2: Adjustable Advanced Back Support chair</p>  <p>This chair is designed in a way that allows the user to move freely while keeping the spinal cord in a fixed position. With the help of the spinal clips that will be attached to the users vest, the backbone will move as one part and not vertebrae by vertebrae. In addition to the 360° movable base, the movable arm allows the user to move horizontally but within the range of locm, making drawing and simple office tasks easy and healthier.</p>	<p>Ahmed Mohamed mohaa97</p> <p>Vest Backview</p>  <p>The vest is made of soft breathable that keeps the user comfortable and with the help of the spinal clip the user will be positioned perfectly. The adjustable body strap exists lower back with the perfect needed support.</p> <p>Vest Frontview</p>  <p>The vest has a shoulder adjustment and a upper back adjustment that has a adjustable fit to the users posture. With the help of the fastener the user can easily wear and remove the vest.</p> <ul style="list-style-type: none"> <li>• Jackson Lippert: Great idea that encompasses many of the problems our client is facing.</li> <li>• Borna Sadeghi: This idea is good for her ankylosing spondylitis (fusing of vertebrae). However, consider that the client experiences pain when sitting still for long periods of time, and therefore likes to move around frequently, whereas this idea will keep her body quite stationary. Additionally, it may be difficult for her to attach herself to the chair, as the spinal clips are small and she can't see them because they'd be behind her.</li> <li>• Andrew Krynski: Great idea for the client's issues, could be difficult to design/build</li> </ul>

Team Number: **Tues-26****Concept 1**

Name: Jackson Lippert

MacID: lippertj

Insert screenshot(s) of your concept below.



*Ahmed Mohamed: Great concept, but the arm rest support should be light and small to allow the user to move easily. In addition, the straps should not be too harsh.*

*Borna Sadeghi: You need to find a way to keep the armrest table stable despite being attached to her body. Also, her elbow shouldn't put too much force on the table, and the table shouldn't apply too much force to her body.*

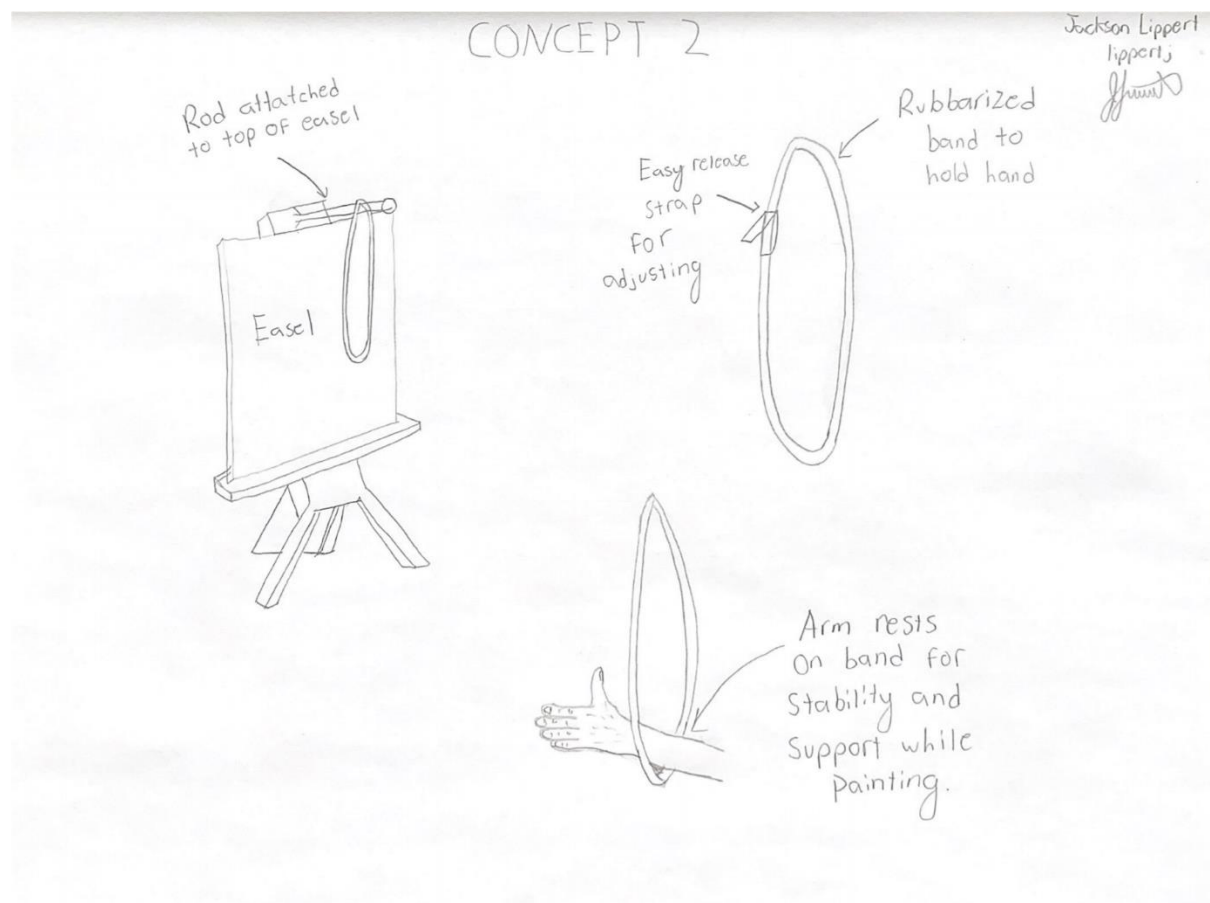
*Andrew Krynski: I like how it supports her arms through the straps, but it could cause added strain onto her spine and the muscles around it*

## Concept 2

Name: Jackson Lippert

MacID: lippertj

Insert screenshot(s) of your concept below.



*Borna Sadeghi: Very smart and simple, but would need to be constantly adjusting the length, especially for up and down movements. Implementing rubber straps to future stabilization designs is a good idea. Perhaps allowing the rod to move with the position of the arm is one step towards solving this issue.*

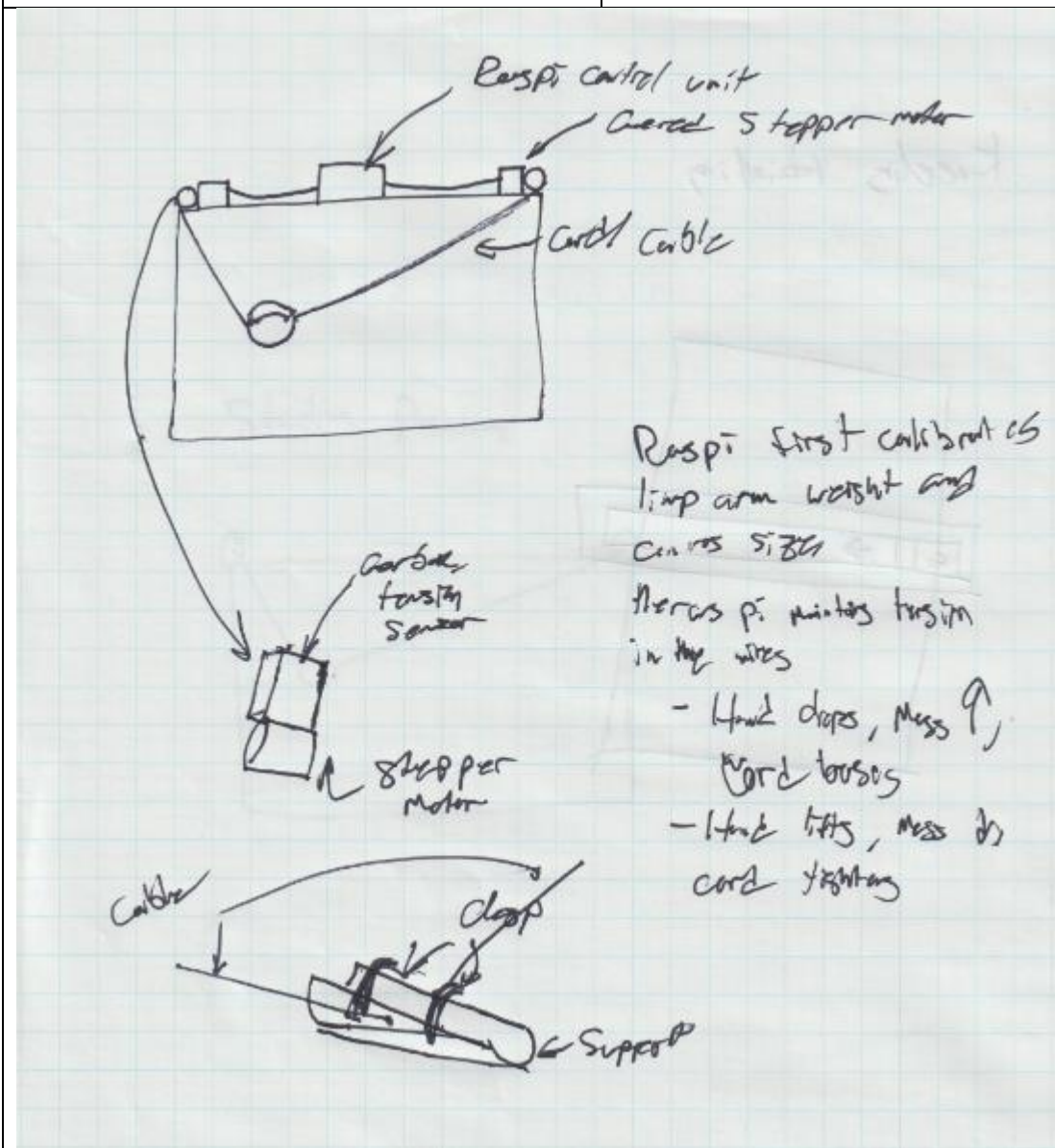
*Ahmed Mohamed: I love how simple and useful this could be, but one thing that should be taken into notice is the rubber hoop as it could be inconvenient.*

*Andrew Krynski: Great idea, very simple, would have to choose materials carefully.*

Team Number: **Tues-26****Concept 1**

Name: Andrew Krynski

MacID: krynskia



Jackson Lippert: Great idea, it is definitely very functional, however we need to make sure this can be made in our time frame.



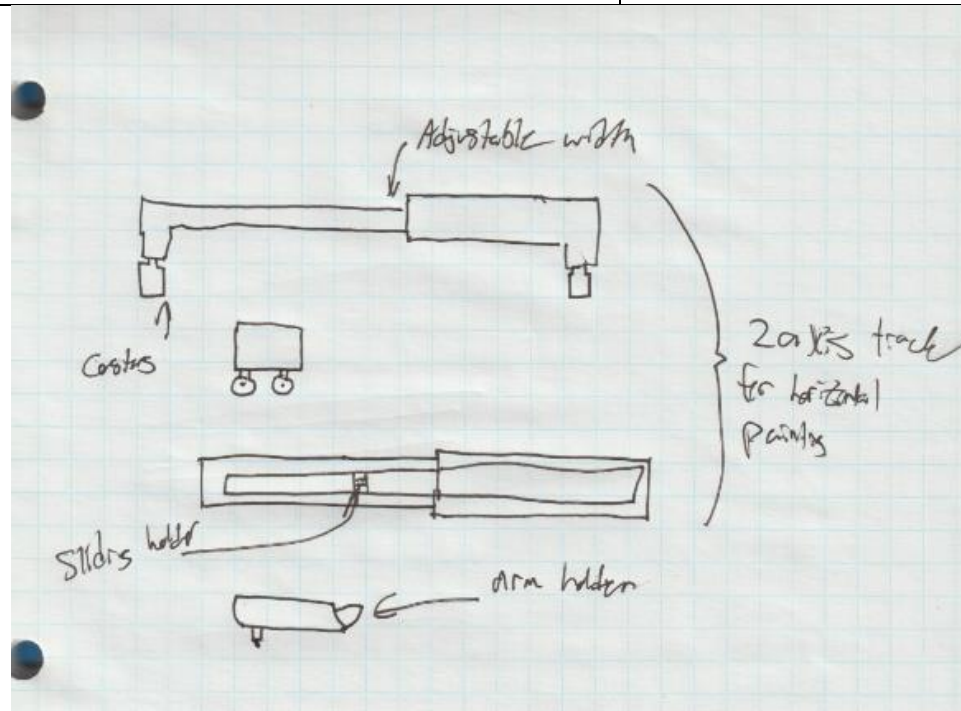
Ahmed Mohamed: Very smart concept, will definitely be very beneficial for the user's scenario, however designing it might be a bit challenging.

Borna Sadeghi: This is a very interesting way to keep the hand stable, and it actually seems quite feasible to create a prototype, however, I believe calibrating the motors perfectly is going to be the most difficult part and it won't be reliable without a lot of tweaking. We may experience problems with the motors moving while she wants to keep her hand still, for example, and due to the varying weight and pressure of her hand on the cables, it may be difficult to predict what the motors should do at a given time.

### Concept 2

Name: Andrew Krynski

MacID: krynskia



Jackson Lippert: I like the simplicity and functionality of your design, great job.

Ahmed Mohamed: Great concept, that could be perfected in a very short period of time, however the arm holder material needs to be chosen carefully.

Borna Sadeghi: Very simple and functional, and could keep the client painting on the ground for longer, as long as it is comfortable. I'm not sure if she can place much weight on the arm holder though, in which case, this becomes more uncomfortable.