PROJECT FOUR: MILESTONE 1 – COVER PAGE

Team
Number:

THURS18

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

Full Name:	MacID:
Vaisnavi Shanthamoorthy	shanthav
Chengyao Liu	liuc169
Jianhao Wei	weij50
Sarah Youssef	yousss6

MILESTONE 1.1 – CLIENT NOTES

Team
Number: | THURS18

You should have already completed this task individually <u>prior</u> to Design Studio/Lab for Week 7.

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

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 their client notes with the **Milestone One Individual Worksheets** document so that it can be *graded*
- Compiling your individual work into this **Milestone One Team Worksheets** document allows you to readily access your team member's work
    - o This will be especially helpful when completing the rest of the milestone

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Team
Number: | THURS18

| Name: Vaisnavi Shanthamoorthy | MacID: shanthav |

Copy-and-paste the notes from the introductory client visit for one team member in the space below.

Client Visit:

Name: Alanna

Age: Early 40's

- **Early 20's → became a midwife**
    - **→ Health care provider (duration: 15 years)**
- **Developed a series of autoimmune diseases that affected her sleep and**
- **Started painting (in 2017) as an outlet & trained in Brazilian Jiu jitsu**
- **Gotten into a car accident**
- **Diagnosed with breast cancer (ongoing treatment)**
- **Resting her hands and her body is her main priority.**
    - **→ One solution she came up with was to paint in her bed to rest her body so that she could still do what she loves which is to paint**

- **What inspires you to do art?**
    - → Is inspired by the fact that what we do right now in our lives is preparation for what we do in the future.
    - → Painting about the parts that aren't easy makes it beautiful.
    - → Through these answers, it is very clear that she is so hopeful and chooses to approach everything in life in a very positive manner.
- **Her body is unpredictable.**
    - → Sculpting is difficult because she does not know what her body is going to do that day.
    - → Challenged with fine motor difficulty due to pain sometimes.
    - → Feels pain to the point where it feels like fire.
    - → Lymphedema → impacts arms (chronic and inflammatory)
        - Even when it isn't active, it can become active.
            - For instance, she said that during a painting showcase, she cut her hand which led to making it active.
    - → Motions that are difficult: bending at the waist is very difficult/painful, she cannot sit or stand for long periods of time.

→ "At different times it varies, my body is unpredictable day to day. I cannot plan to work on a particular day. Sometimes fine motor due to pain, muscles being impacted (fibromyalgia), lymphedema in arms (chronic, inflammatory) is triggered by any cut, so impacts or injuries need to be avoided."

→ She said that she tends to be clumsy so working with fine things, so it is vital that she takes extra caution.

- **Are you open to digital means of painting?**
  → Has not explored a lot in terms of a digital means of painting.

  → Also stated that it is not that the client is not interested in this method of painting but part of creating art is that it makes her feel alive, she wants to be able to touch it, be a part of the process

  → A digital means of painting doesn't make the client feel like they are engaging their senses in the same way.

  - Drawing in my free time, I definitely understand how Alanna is feeling here, having that personal aspect of engagement with your work just makes it that much more special, and having the actual feeling of holding a paintbrush or a pencil when painting or sketching makes it that much more personable.

  → Additionally, things like even holding a pen → leads to pain as well.

- **How has COVID-19 affected your daily activities, how have you adapted (yoga, etc.)**
  → Only gone to doctors' appointments (mandatory)

  → Hasn't gone to a gym since early March

  → Transferred from Jiu jitsu to yoga during the pandemic

- What is the biggest roadblock or impediment to doing the things you love doing?
  → Dealing with unpredictability

  - This seems to be an ongoing roadblock for her, and it is clear how strong she is for finding methods to still do what she loves

- When working with painting the other day
  → SI joints were so locked up where standing or sitting painting was uncomfortable

  → Her solution: She put her painting on a stool, while she was kneeling on a pillow and bearing her weight on the side of stool

- Sculptures
  → Early on, she took a pottery class

  → Doesn't like pottery because it didn't work well for her

  → Likes sculpting with wire maybe because she also has a background in sewing & being a midwife has experience with dealing with similar tools to wire

  → Although wire hurts her hands, she wants to do it more.

  - When the client mentioned this, it clearly stood out to me of much of a fighter she is, rather than quitting, she wants to make the activities she loves doing work.

- Has a gluten allergy so paper mache is not an option

- Which joints cause the most issues?
    - Primarily the spine, the right shoulder, and the wrists/hands
- Are you using any tools/products to aid with lymphedema and ankylosing spondylitis at the moment? What are some ways you believe these products could improve?
    - → For Lymphedema: wears medical compression sleeves and compression vest when painting or exercising.
        - Alanna states that they are helpful for being more functional but they are not comfortable, partly because she has fibromyalgia, which makes some things on the body feel uncomfortable
            - Needs soft textures
    - → For Ankylosing spondylitis (type of arthritis): has used brace or belt for walking but otherwise uncomfortable, has also tried to create a posture necklace but found it did not work, most adaptations are postural → for instance painting on the floor or on the bed as mentioned previously.
- You mentioned being a parent, how has this challenged being able to interact with your kids?
    - → She mentioned it being a challenge, "they are young and rambunctious", physically they are almost bigger than she is.
    - → The physicality of parenting is something she misses; it's changed a lot
    - → It is the hardest when a new condition emerges, and energy goes into care for it. All in all, it's hard to have enough energy for everyone, emotionally exhausting.

Side Notes:

- Lymphedema
    - → Swelling generally occurring in arms, legs or both, commonly caused from removal or damage of lymph nodes from cancer treatment.
    - → Symptoms: swelling, feeling of heaviness, restricted range of motion
- Ankylosing Spondylitis
    - → an inflammatory disease that, over time, can cause some of the small bones in your spine to fuse.
    - → Symptoms: pain and stiffness in lower back and hips, neck pain and fatigue are also common.

Team
Number: | THURS18

Name: Sarah Youssef	MacID: yousss6

Copy-and-paste the notes from the introductory client visit for one team member in the space below.

Client Name: Alanna

Age: early 40s

- developed an autoimmune disease that impacted her sleep
- Got into a car accident that impacts her physically
- receives ongoing treatment for breast cancer
- sometimes forgets limitations and strains body
- any cuts in skin have a high probability of infection (led to giving up sewing)
- Experiences with past solutions:
  → uses tens machine, acupuncture, cupping, self-acupressure, vibrating heat belt on SI joint
  → claw mechanism does not work for picking objects off the floor
  → medical compression sleeves and vest feel uncomfortable, needs softer textures
  → mentioned that most pain management has been postural changes on her end (ie. changing working positions)
- Fine Motor / Motion Difficulties:
  → wants to sculpt more but is unable to due to a lack of support on dominant hand
  → movements like bending at the waist and up and down movements are particularly difficult, but crouching and squatting are okay
  → any kind of load bearing on arms is difficult
  → biggest challenge is not being able to predict lymphedema "flares", causes an unpredictability in holding up arm and small brushes
  → finds the physicality of parenting difficult; can be draining and emotionally exhausting
  → looking for tools to make activities such as painting and gardening less painful, and to support the body in challenges with gentleness
  → spine, right shoulder, wrists / hands are the bones / joints that cause the most difficulties

Team Number: THURS18

Name: Jianhao Wei	MacID: weij50

Name: Alanna

Age: Early-40's.

-She become a midwife in her 20's, and she continue to do it unit 15 years later.

-She got into a car accident later in her life

-She develops some autoimmune diseases, which affect her sleep and daily life.

-She also has Ankylosing and Chronic lymphedema which cause inflammation of her spine and also cause excessive bone growth.

-She also diagnosed with breast cancer

-She sometimes has really bad pain and inflammation. These symptoms are very unpredictable, it can happen anytime during the day and night.

-Her biggest challenge is to deal with the unprediction of her symptoms.

-She really likes painting and sculping. But her disease prevents her from picking up fine equipment.

-She also like sewing, but her give up because she's afraid of the needle being stabbed into her hand and cause infection

-She also really like exercising yoga and meditation, which helps her to relax her stress from her symptoms.

-She also can't pick up heavy things, which will lead to bad pains on her arm

-She also has to rest he body for a while after working for a long time.

-She sometimes ignores her body limit and continue to work. This makes her symptoms worse.

-She also doesn't like to paint digitally instead.

-She doesn't like to have wires on her hand.

-She also allergic to glue. So she can't create stuff with glues, such as paper mache.

Team
Number: | THURS18

| Name: Chengyao Liu | MacID: liuc169 |

——*Client name:* Alanna

——Background information:

    -Retired from the head of Midwifery.

    -A painter.

    -A mother of two children.

——*Diseases:*

    -Autoimmune diseases

    -Ankylosing spondylitis which causes inflammation of her spine and other joints leading to excessive bone growth and fusion of her vertebrae.

    - Recent breast cancer survivor

    - Chronic lymphedema in her arms, chest, and back (arm and shoulder being the most

      affected)

——*Hobbies:*

    - Carving

    - Sculpting

    - Gardening

——*Daily life:*

    -Painting (but only few minutes).

    -Sculpting (one of the things she primarily spends time doing).

    -Meditates, stretches, and exercises daily.

    -Trains in adapted Brazilian Jiu Jitsu (for rheumatism).

——*Problems we meet (maybe need to solve)*

    - Her body is unpredictable.

    -Her arms and shoulders have the most serious lymphedema, so she can't draw for a long time and can't bear too much weight.

    - She likes gardening, but it hasn't been introduced into her life.

> *- She stopped sewing because of the risk of stabbing her hand and infection. Reasons are increased nerve pain and her lymphedema.*
>
> *- Not very receptive to digital painting.*

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

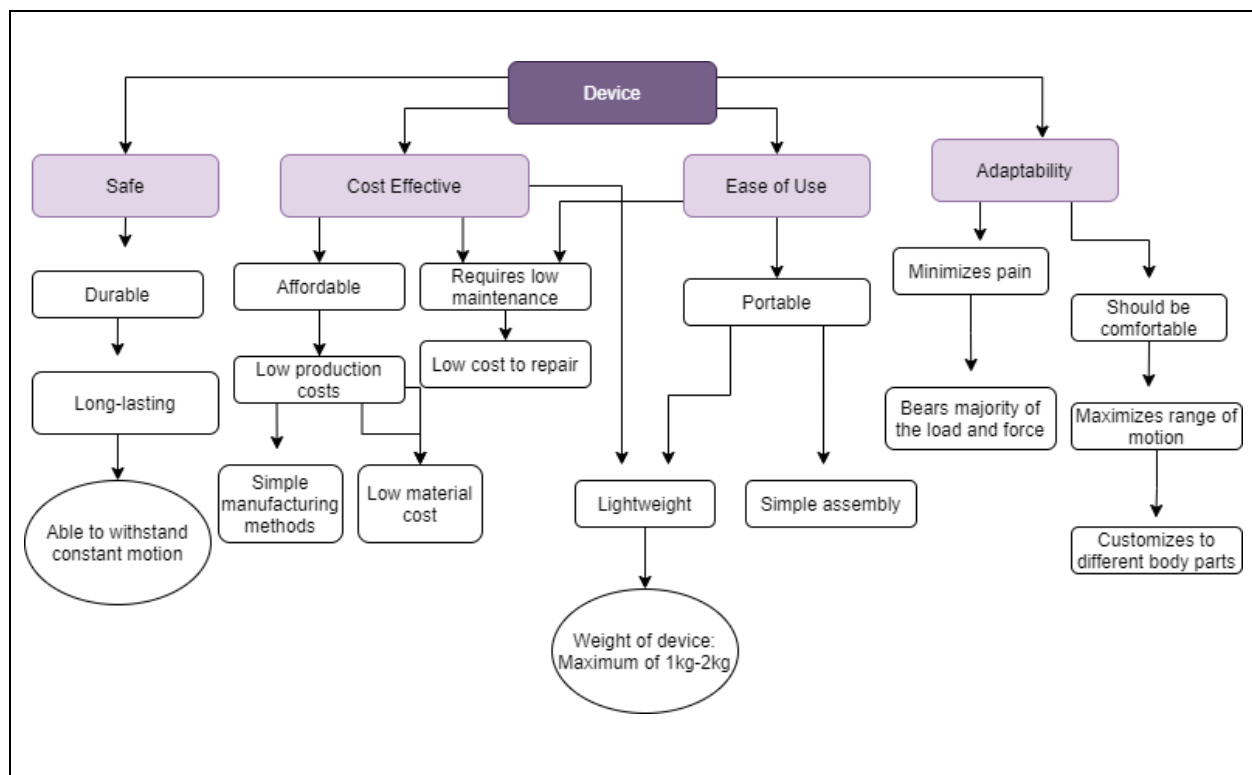# MILESTONE 1.2 – INITIAL PROBLEM STATEMENT

Team Number: THURS18

1. As a team, come up with an initial problem statement and include it in the space below.
   → Make use of your client notes to define your primary function
   → Remember to avoid solution-specific statements
     o Focus on what your design *should* do for the client in a general sense (not *how* to do it)

> Design a device that focuses on allowing Alanna to continue to take part in her daily activities whilst effectively managing any form of pain that she encounters as she is challenged with fine motor difficulties and unpredictable periods of pain.

MILESTONE 1.3 – OBJECTIVE TREE, HOW/WHY LADDER, METRICS

Team Number: | THURS 18

1. As a team, use an objective tree and/or How/Why ladder, to refine and guide the focus of the project.
   → If your team chooses to do both, copy and paste the blank box on a separate page
   → Your diagram(s) can be hand-drawn or done on a computer. Please make sure it's well organized and **readable**.
2. If you need to see examples of each tool see "Review of Design Process" lecture – Wednesday, Feb 24th.

Justify your team's reasoning behind the choice of design tool(s):

An objective tree as we know is a hierarchy of objectives for the design. We chose to use an objective tree over a How/Why ladder in terms of our design tool of choice for this step of the engineering design process, since it seemed to aid us more in selecting which objectives would and would not be appropriate for our initial problem statement. Additionally, the objective tree aided

in formatting all our ideas in an organized manner, where all our objectives essentially branched out to our specific constraints paving a more solid idea of what our potential plan for this project could entail. Furthermore, the objective tree was an easier and faster method of viewing the main objectives for this project. With its hierarchical aspect, it provides us with the ability to move from simple objectives to more detailed ones as we move down the branches. The objective tree provides us with concrete objectives that will allow us a group to make decisions regarding the overall effectiveness of various designs further on in the project. In terms of the How/Why Ladder and why we did not choose that as our design tool, we feel as though it is a useful tool but is not as effective in this case as it does not provide an organized structure in terms of concrete ideas for us to be able to judge the effectiveness of the design. All in all, the objective tree best aided us in this stage of design process to highlight all the necessary and appropriate objectives for this project.

1. What are your top three objectives (in no particular order)?

Low Production costs
Adaptable
Lightweight
Durable

2. What is your rationale for selecting each of these objectives? Write maximum 100 words for each objective.

Objective 1: Low Production Costs

Rationale:

Low production costs are a key objective as this device is intended for personal use and is specifically designed for one client. Thus, it should be made to be inexpensive and as affordable as possible for the client. With that being said, speaking in terms of the production side, the equipment should not consist of too many complicated parts, and instead use less expensive material while at the same time satisfying other conditions.

Objective 2: Adaptable

Rationale:

Adaptability was another key objective as the client mentions often that the pain she encounters can be both unpredictable and can occur in different parts of the body at any time. For this reason, the device designed should be adaptable to the client's body and be able to bear loads at different points of the body, depending on which area is in the most painful at a point in time. The client has

also mentioned that most of her pain relief is from postural changes, and a device that is able to change form and adapt easily would allow the client to work in one posture for longer.

Objective 3: Lightweight
Rationale:

The client has mentioned having difficulty with fine motor skills as well as withstanding various loads with the affected bones, joints and muscles. For this reason, the designed device should be lightweight in its final form as being lightweight would stop the device from adding any additional load to the affected body parts. A lightweight device would also be easier to move around and attach, so the client does not face any difficulty when moving the device around or setting up the device for use.

Objective 4: Durable
Rationale:

The client has mentioned that she is highly susceptible to infections, even from small cuts and pricks; and this susceptibility has led to some of her higher-risk activities being discontinued, like sewing and gardening. Because of this, the material of the device should be durable and be able to withstand needles and gardening tools. The client also uses art as an outlet and is a treasured activity for her so the device should be able to withstand constant rubbing without decreasing functionality; in order to maintain her lifestyle.

3. Fill out the table below with associated metrics (including units) for each objective.
   Remember: Metrics should be something you can actually test or measure as part of your process (e.g., calculate weight of a part by iProperties in CAD, test results of a physical prototype).

Objective:	Low Production Cost
Unit/Metric:	**1** = cost < $80, **2** = 80$<cost<160$ **3** = 160$<cost<250$ **4** = cost>250$

Objective:	Adaptable
Unit/Metric:	1: Able to conform to / relieve pain from at least 4 joints (+ spine) 2: Able to conform to / relieve pain from only to wrist / hands / shoulder 3: Able to conform to / relieve pain from only wrists and hands

Objective:	Lightweight
Unit/Metric:	1: Weight =< 100g, 2: 100g < Weight < 500g 3: 500g =< Weight =< 1kg 4: 1kg < Weight =< 2kg

Objective:	Durable
Unit/Metric:	1 - able to withstand rubbing motions for 10 hrs without any wear-and-tear, as well as being impenetrable to needles and gardening tools 2 – able to withstand rubbing motions for 5 hrs without any wear-and-tear, as well as being minimally penetrable to needles and gardening tools 3 – able to withstand rubbing motions for 1 hr without any wear-and-tear, as well as being somewhat penetrable to needles and gardening tools 4 – not able to withstand rubbing motions without any wear-and-tear, as well

	as being somewhat penetrable to needles and gardening tools

MILESTONE 1.4 – PROJECT PLAN

Team Number: | THURS 18

1. As a team, outline a project plan where you:
   → Include a few sentences describing each team member's prior experience with physical and/or software prototyping
     - From previous projects in the course, or any other relevant experience
   → Compile a list of potentially useful resources, materials, and/or tools for prototyping

Reminders:

→ The prototype can be either physical (e.g., cardboard and tape, 3D printed), digital (e.g., Inventor simulation or rendering), software (e.g., code for Raspberry Pi) or some combination of physical, digital and software

→ Keep in mind that there are no ENG 1P13 physical prototyping resources available to you because we are learning online, which is why we are asking you to take inventory of how you might accomplish prototyping as a group

→ As you think about how to prototype, remember that you will eventually need to validate your work somehow. Your validation approach will depend on what prototyping technique you use. Examples of validation approaches include (but are not limited to): hand calculation, physical test, software demonstration or simulation.

Each Team Member's previous experiences with prototyping:

Sarah Youssef (yousss6):

- Project 1: Wind Turbine
    - Learned how to effectively develop a decision matrix and objective tree and this will be helpful in using both tools in developing solutions for the client
    - GRANTA EduPack: learned how to research materials and their properties in order to learn their behaviours.
- Project 2: Get a Grip
    - Experience with Python: experience in coding a program to solve a particular presented problem (a continuous program that deposited 6 different containers to 6 specific locations
        - Project Planning: Started with an initial flowchart that outlined the general process that would be required, then moved on to a pseudocode program that outlined the functions and the specifics of those functions without using syntax. The final step was implementing the pseudocode into an actual Python program and spending a lot of time debugging the program in order to properly carry out the objectives
- Project 3: There's a Recyclable Among Us
    - Experience with device design / Autodesk Inventor: Experience with developing ideas for a device that output rotational motion and modelling these devices in Autodesk Inventor
        - Assembly:
            - working with parts and their relationships in order to completely model a device that effectively output rotational motion about an axis
            - Worked with using motion constraints and forming relationships between parts that would cause the motion of the hopper
        - Dynamic Simulation:
            - Understanding joints and their relationships in a dynamic simulation in order to show all the required positions of the hopper
        - Project Planning:
            - Initially formed ideas using the requirements listed in the project module and came up with multiple ideas that were filtered using a decision matrix
            - Had to change / alter ideas multiple times due to unexpected outcomes in the solid modelling process; future ideas were then tested out in AutoCAD first

Vaisnavi Shanthamoorthy (shanthav):

- Project 1: Mechanical Design of Wind Turbine Blades in Renewable Wind Technology
    - Experience with GRANTA EduPack: Had the opportunity to work with the software and my group to pick the best material for our specified scenario
        - Produced MPI Charts to choose the most appropriate material based on the various material properties
    - Project Planning:
        - Introduced to new concepts of developing our ideas through the engineering design process such as through:
            - Objective Trees
            - Decision Matrix
    - Experience with presenting our proposed solution regarding our scenario to our peers.

- Project 2: Get A Grip
    - Experience with writing a flowchart and pseudocode
        - My partner and I both began with making individual flowcharts of the processes we envisioned for our program to do at each individual step of the way, we then compared and adjusted our flowcharts into one main set of steps. This was then turned into a pseudocode which we then turned into writing our various functions.
    - Experience with Python
        - Successfully coded a program to execute various functions such as being able to successfully transfer containers such that they are deposited in the correct containers in order to be sterilized.
        - Ran numerous tests in a virtualized Q-Labs environment to ensure that each aspect of our program ran smoothly.
    - Experience with presenting our proposed solution in our final presentation.

- Project 3: There's A Recyclable Among Us
    - Experience with Autodesk Inventor
        - Project Planning
            - Experience with making concept sketches & reiterating the engineering design process by making adjustments to them. My team and I started off by each individually making concept sketches of what we envisioned our mechanism to look like and how it would work. We then met up and presented each of our ideas, and sort of combined aspects

of all our ideas to form our final plan for our main mechanism.

- Assembly
    - o Made various sub-assemblies pertaining to our specific goal for our mechanism to deposit containers into the recycling bins
    - o Assembled all the sub-assemblies into one final main assembly where we had to apply various constraints and such to do so
    - o Experience with making engineering drawings for each of the various sub-assemblies as well as the making of the final exploded assembly for our final solid assembly
- Dynamic Simulation
    - o Worked with my group to produce a simple yet effective motion simulation with our linear actuator, we executed a simple dynamic motion simulation of the actuator extending so that our mechanism would be able to lift the hopper to deposit the containers and return back to its home position after doing so.
    - o Experience with the making of the motion graphs specific to our motion simulation.
- Experience with presenting our proposed solution in our final presentation.

Chengyao Liu (liuc169):

- Project 2: Get a Grip
    - o Experience with Autodesk Inventor.
      I learned how to compose 3D images and make medical containers. Learned 2D sketch and 3D exclusion, cut, mirror and other tools. Designed a container with a lid. The external part of the container is provided with protrusions, in order to be more stable in the process of mechanical arm clamping and moving, and the internal part of the container is also designed so that the internal medical devices can be fixed in the process of moving.
- Project 3: There's A Recyclable Among Us
    - o Experience with Python.
      My main job was about main function, transferring function, and return home function. Realized:
        - Execution of the whole process from distribution to loading then transferring and finally returning home.
        - Making the q-bot start running after completing the condition.

- The distance between the q-bot and the target bin is detected and updated continuously by the sensor.
- The q-bot can go to different bin and stop in front of it according to the different containers.
- The q-bot can return to the starting point along the yellow line after dumping.

Jianhao Wei (weij50):

- Project 2: In project 2, I learned about how to code in Python to deliver the appropriate command to the mechanic arm to perform multiple tasks, including find the location of the container, pick it up, and put them in the appropriate sterilizer. I learned about the delaying nature of the robot arm. I learned to define different functions and set loops for repeating tasks to write the code logically to minimize errors. I also learned how to develop a test plan to test out my functions to make sure my functions work properly.
- Project 3: In project 3, I was in the modeling sub-team. When working with inventor, I learned how to constrain different objects together and how to use different types of constraints (such as mate, tangent, etc.) to create the assemblies with appropriate degree of freedoms. For solid model, I learned how to create different types of solid models from engineering drawing by extruding from 2D to 3D, and also how to modify the size of the solid model to fit the overall assembly. I also created a dynamic simulation with my partner to show customers how our product works and generated the normal and exploded engineering drawing in inventor.

Project Plan for Project 4:

We have decided to implement both a physical and software aspect to the device, as this would be the best option to relieve pain from certain daily activities of the client.

List of potentially useful resources, materials and/or tools for prototyping:

- Raspberry Pi: Using the raspberry pi, we could use python in order to develop a program that would further aid in developing our device. Using the various elements python has to offer, the options are endless. This resource we allow us to be able to develop a program within python to be able to effectively create our envisioned design for this device down the road.
- Autodesk Inventor: using this program could prove to be very beneficial in both the initial and final steps of this project. The program's modelling / assembly functions makes it a very useful tool in low-fidelity prototyping (and seeing if the assembled prototype carries

out the desired output), while also being a useful tool for modelling and assembling our final device if need be.

- GRANTA EduPack: We can select materials, which can realize 'low production cost', 'lightweight', and 'durable', by using GRANTA. When making prototypes, it is good to test materials properties and gives us advice about material choosing because the platform contains database and related application cases about material.
- Physical Materials (that can be easily found and modelled): Physical models and low fidelity prototypes can be easily modelled using materials that can be found at home, and making a physical prototype will make it easier to see / visualize the mechanisms and how they work once they are put together.
  - Some examples of physical materials (but not limited to) that can be used to create our low fidelity prototype include:
    - Cardboard
    - Paper
    - Wire
    - String
    - Tape
    - Glue
    - Etc.