Deliverable C

1. List and prioritize client needs/problems and define all relevant known and unknown information.

List of needs/problems	Prioritize (1 is the lowest, 10 is the highest)
Being able to open the window automatically	9
Window can be opened by someone else while the mechanism is still attached	7
Can use a remote app on iPhone to open the window automatically	9
The mechanism that opens the window must be durable and reliable	10
The mechanism cannot block the function of the blinds	8
Mechanism can detach so the window can be cleaned	7

Relevant knowns:

The client would want the mechanism to be white so it would blend in with the backsplash of the room so that it does not stand out too much. We can use screws to mantle the device to the wall, so a more permanent thing works. If we can program the software with a bit of customization the client would like the window to open part-way, as well as a potential scheduler so that it will auto-close when it hits a certain time of day.

Unknown information:

How much force does it take to open the window which will affect the motor that we would have to buy to open the window? If the cold temperatures from the outside would affect the opening and closing of the window.

2. Problem statement

The client needs a user-friendly system to open and close a sliding window remotely. The system must be reliable, including the ability for manual operation, slim so the blinds can close, and have different controls for the client and caregivers. As well we will need to be able to take the mechanism off the window so that it can be cleaned. The product we make should embody all these qualities to satisfy the client's needs, with the design we are making the client should be satisfied and be able to use it in their house.

3. A list of need inspired metrics and benchmarking.

Slimness (Dimensions):
Definition: The physical dimensions of the system to ensure it is slim enough for blinds to close over it.
Metric: Thickness and width of the system.
Unit: Millimeters (mm).

Remote Control Range (Meters):
Definition: The maximum distance from which the sliding window can be operated remotely.
Metric: Maximum distance achievable.
Unit: Meters (m).

Noise Level (Decibels):
Definition: The level of noise produced during the opening and closing process.
Metric: Noise level recorded during operation.
Unit: Decibels (dB).

Longevity (Hours)
Unit: integer (number of times it
Definition: Use the number of hours the motor can run for to determine the total number of times the window will open and close
Metric: The lifespan that the electric motor has (How long the window opener will last)
Unit: Hours (H)

Securing strength (Kg)

Definition: The amount of weight that the screws can hold determining the max weight of the window opener.

Metric: How many pounds that the screws can take

Unit: Mass (Kg)

Generated load (N)

Definition: Amount of force being applied to window

Metric: Produced force

Unit: Newton-meters (N)

- **Smart Window Opener X1:**
  - **Slimness:** 20mm thickness, 60mm width

- **Remote Control Range:** 35m
- **Noise Level:** 42 dB
- **Longevity:** 15,000 hours
- **Securing Strength:** 20 Kg
- **Torque:** 10 N·m

- **AutomatePlus Window Operator:**
- **Slimness:** 18mm thickness, 55mm width
- **Remote Control Range:** 30m
- **Noise Level:** 38 dB
- **Longevity:** 12,000 hours
- **Securing Strength:** 18 Kg
- **Torque:** 8 N·m

- **HomeGuardian Electric Window Actuator:**
- **Slimness:** 22mm thickness, 65mm width
- **Remote Control Range:** 25m
- **Noise Level:** 45 dB
- **Longevity:** 10,000 hours
- **Securing Strength:** 22 Kg
- **Torque:** 12 N·m

Table 3: Technical Benchmarking

Products	Expense ($)	Slimness (mm)	Remote Control Range	Noise Level (dB)	Longevity	Securing strength	Generated load (N)
Olide Automatic Slide Open Window Actuator Opener Motor, Home Sliding Window Automatic Electric Window Opener	404.45	50000	N/A	N/A	N/A	N/A	200
KST-SL02 series Track Linear Actuator	109	580-1180	N/A	48	N/A	N/A	200

This table is a comparison between the 2 products we found online to find which one would potentially be a good fit for the project. When looking at it, it is obvious that they are quite expensive for their needs for the client.

KST-SL02 series:

This product is a compact, DC track linear actuator for sliding windows. It can handle up to 200 Newtons of force and easily switches between manual and automatic modes. It's part of a DIY kit for electric window upgrades.

https://www.soonkst.com/track-linear-actuators-kst-sl02

Olide Automatic Slide Open Window Actuator Opener Motor, Home Sliding Window Automatic Electric Window Opener:

The Olide Automatic Slide Open Window Actuator is a motorized system for home sliding windows. It allows for remote control operation using additional sensors and can be manually operated in case of power failure.

https://www.amazon.ca/Olide-Automatic-Electric-Sliding-Actuators/dp/B01DKGDRP0?th=1

4.Target specification

Metric	Units	Marginal Value	Ideal Value
Size	mm	35 mm thickness, 80 mm width	20 mm thickness, 60 mm width
Remote Control Range	M	>3	>25
Noise Level	dB	<60	<42
Longevity	H	>15000	>18000
Securing Strength	Kg	18-22	25-30
Generated Load	N	200	300
Reliability	Measured as a 1 if it can function without a WAN connection and a 2 if it can function without a LAN connection	1	2

Size

We want the size of the device to not exceed 35 mm thickness, 80 mm width. This will ensure the device won't be too big and take up a lot of space. This is something the client was admit about, they didn't want it to take up space on the window or be too bulky.

Remote Control Range

The remote-control range needs to be 3 meters minimum as per the client's request. We would like it to have a longer range than 25 meters so the device can be controlled from a different room in the house.

Noise Level

The noise level is important to have no more than 60 decibels (dB) which is as loud as a normal conversation. This will prevent any harm to the client's ears while operating the device. But preferably we would like it under 42 decibels, this is close to average home noises which would then blend into the house very seamlessly.

Longevity

We want the device to last for minimum 15000 hours of usage. Ideal value would be 18000 hours. The longer the device lasts and the less the client will need to replace it.

Securing Strength

We need a securing strength of at least 18-22 Kg, this means the device can't exceed this weight. The ideal securing strength would be 25-30 Kg, this allows us to have more sturdy components.

Generated Load

We need the generated load to be at least 200N, this is to ensure that it will be able to open and close the window. Having a generated load of 300 N would allow for a smoother opening and closing of the window, as well as ensuring the motor doesn't burn out if it requires more than 200 N.

Reliability

We need the system to be reliable due to safety concerns of the client, relating to her lack of ability to regulate temperature. Having the system be able to function without internet connection is required, but having it function without the client's network working would be ideal.

1. Ideas of potential designs

Hardware side

Idea 1:

As the motor rotates, it will move the first part of the arm directly attached to it. As this first arm rotates around the output shaft of the motor it will push and pull the window. Therefore, if the arm is all the way to the right the window will be closed, if the arm is all the way to the left the window will be fully open.

The main takeaway with this design is that it would be strong enough to be able to move the window easily and would be off to the side of the window and out of the way. We would use mechanical movements to move the window easily and this would create little to no noise for the client. The only problem is that it might be a little larger on the wall and might not be as physically appealing to the client.

Idea 2:

The window will open by using a motor and a piston-like mechanism. There will be a suction cup at the end of the arm which will take the force of the window to open and close it. This will mean that the suction cup might have to be replaced every once and a while since it might lose its function over time. The motor must be strong enough to push the window horizontally while having the suction cup at the end of the piston rod.

The good thing about this design is that it is compact and would make little noise for the client. The main problem is that it might block some of the window and if it is too wide it would also block the function of the blinds, lastly with the suction cup they would have to replace it every once and a while since the effectiveness would go down over time.

Idea 3:

The window will be opened by a rod that has a clamp at one end and is connected to a gear box at the other. The rod that is connected to the gear box will have notches in the rod. When the gear box is operated the gears will move the rod forward and backwards depending on if the client wants it open or closed. The device will be fastened to the studs in the wall and will be powered by a cord connected to a receptacle.

In this design there will be no obstruction of the view that the client wanted with the project, it is also made with gears so that there is a reduction in the noise. The main problem with this design is that there will be a gearbox on the wall which the client may not want to have on their wall, as well as it might get expensive if we cannot get some good gears to move the rod across the window.

Idea 4:

The window will be opened by having a chain wrapped around the gears. The chain will span the length of the window. Along the chain, there will be a block with a rod which connects to the window. So, as the chain spins the block and window will move along with it.

With this design, the main part that will be nice for the client is that it will be strong in structure and will be able to withstand a large force load, it will also be out of the way of anything that would block the windows. The main issue is that it will be a long block below the window which might not be appealing to the client, the other consideration would be the chain since if it rusts quickly, it will be a pain to fix in the future.

Idea 5:

The window will be opened using the tension from cables. There will be two gears or wheels at either end of the window with a belt or chain wrapping around the two. There will be axles attached to the wheels/gears with spools. As the gears spin one cable will be in tension and will be spun onto the spool and the other wire will be spun off the spool.

This design is abstract which makes it have some great positives and few negatives. The positives are that this system would be quiet since its main components are gears and ropes, this would also have a similar layout to the previous model where it would be a long box but now it has 2 rods sticking up to move the window. The main negative is that it might not be appealing to the client since this mechanism might be a bit complicated and might confuse their housekeepers.

Software

Idea 1

An app which connects through WIFI to the device. The app would use the Networking capabilities of the users iPhone to connect with the device through the user's home internet.

The advantages of this solution would be that it could connect to the device from anywhere in the house. It can also take advantage of established communication protocols which would make programming easier, and the product more reliable. The downsides are that it is reliant on the home network remaining online which reduces reliability, and it would not be accessible from outside the user's house.

Idea 2

An offsite permanent server. This would act as an intermediary which would allow the client to interact with the system through a website. The server would then send requests to the device.

The advantages of this solution are that it is customizable as it a server can be communicated with through an app, a website or any other system that can access the internet. It also offers an excellent range, with access from anywhere with an internet connection. The disadvantage is that if there are issues with reliability, as if there are issues with either the home network, the server, or with the internet service provider the connection will fail.

Idea 3

An app which connects through Bluetooth to the device. The app would use the Networking capabilities of the users iPhone to connect with the device wirelessly.

The advantages of this solution are that it offers excellent reliability as it is only dependent on the device and the user's phone and there are no intermediaries that can fail. It would also have the advantage of using established Bluetooth communication protocols which should improve both reliability and ease of building. The disadvantages are that it offers reduced range at the 100m offered by Bluetooth Low Energy.

2. Analyze and evaluate all concepts against the target specifications you defined.

Hardware

5 being the best rating and 1 being the lowest rating based on the client's needs/wants

	Idea 1	Idea 2	Idea 3	Idea 4	Idea 5
Size	3	4	4	3	3
Noise	4	3	3	3	3
Longevity	4	2	3	2	4
Securing strength to the wall	5	3	2	4	4
Generated load	5	4	5	3	4

Software

Solution #	Idea #1	Idea #2	Idea #3
Reliability	1	0	2
Remote Control Range	30m	Infinite	100m

3. Choose one or a few promising solutions you wish to develop further based on your evaluation.

Mounting:

This design would mount the body of the device onto the wall next to the window. There will also be a mount that connects the arm onto the window (connected lower on the window to reduce window blockage)

Motor strength:

If the motor selected is not strong enough to move the window, then there will be gear reductions made to increase the resulting torque on the arm that opens the window.

Design:

There will be an arm connected to the motor and this arm to the window frame. This arm will have to be flat to ensure that the arm does not interfere with the blinds.

Size:

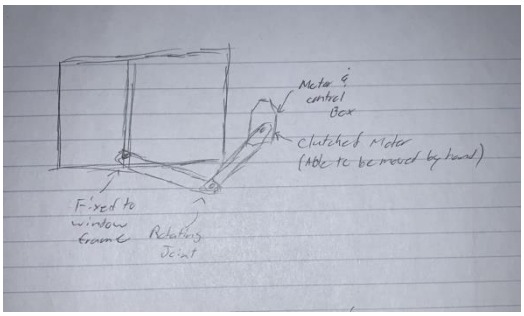
The size of the cases is between 20-35 mm thick and 60-80 mm long

Software

We plan on developing Idea #3 further as we believe that Reliability is significantly more important than Remote Control Range.

4. Global design concept

For the global design for the project, we went with design 1 since it would be the easiest model to create and would be able to withstand the force needed to open the window. The reason is that it would be able to withstand the force needed to open the window the best compared to the other designs. Also, the mechanism to take off the arm from the window is easily done, and minimal blockage of the window view.



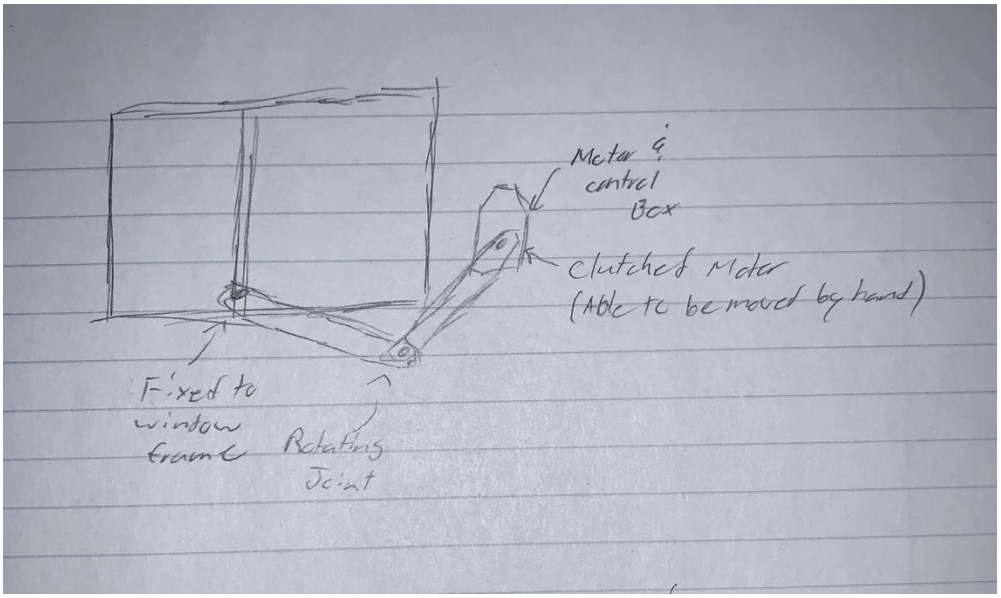
Description of functionality:

As the motor rotates, it will move the first part of the arm directly attached to it. As this first arm rotates around the output shaft of the motor it will push and pull the window. Therefore, if the arm is all

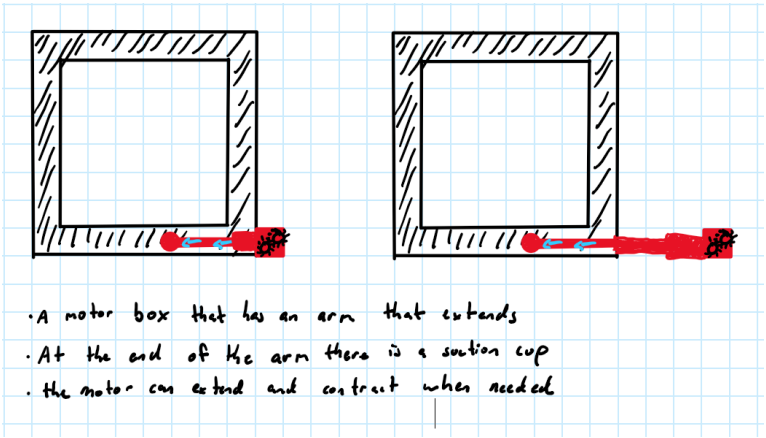
the way to the right the window will be closed, if the arm is all the way to the left the window will be fully open.

5. Visually represents all ideas and global concepts.

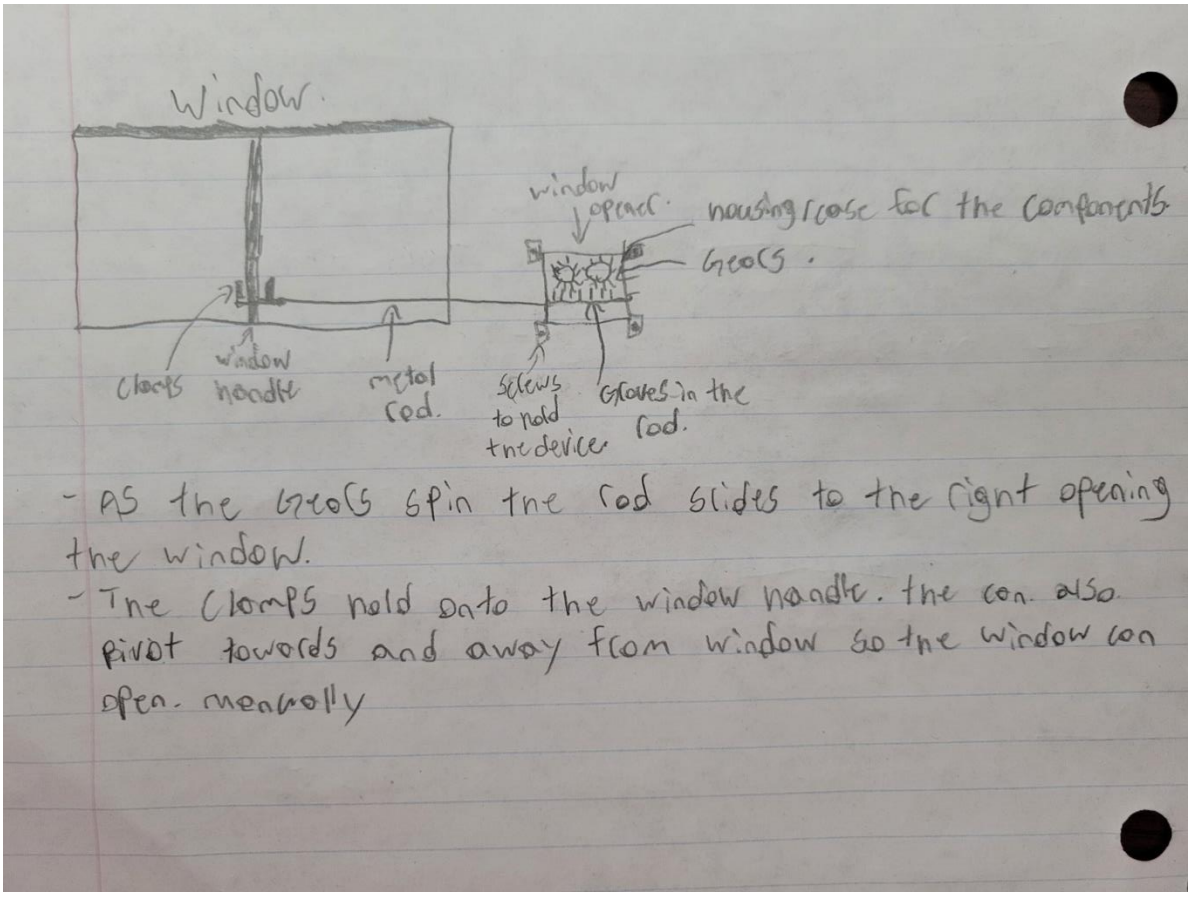
Idea 1:



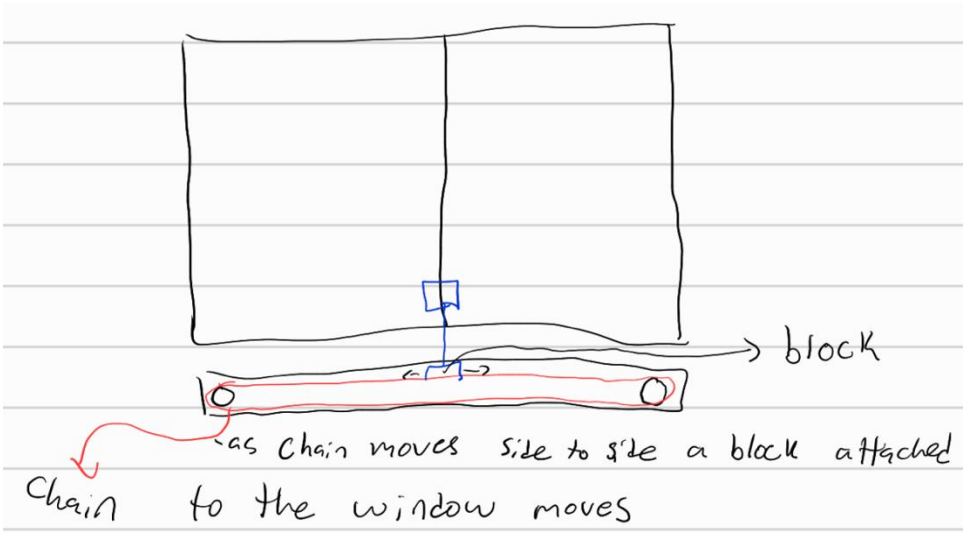
Idea 2:



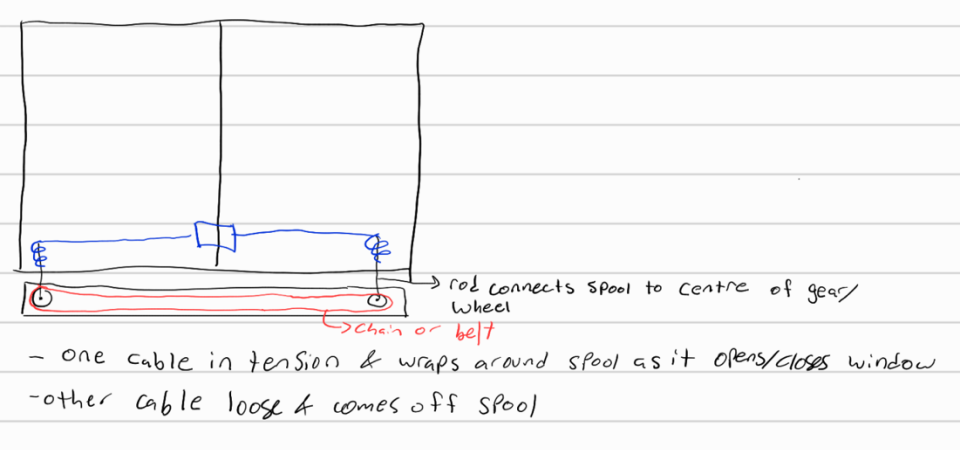
Idea 3:



Idea 4:



Idea 5:



Project Plan Update:

https://uottawa-my.sharepoint.com/personal/etrai055_uottawa_ca/_layouts/15/guestaccess.aspx?share=EasZRpdAgZlIjK4nFhJKJn0BN_HTIq0AY5FYi-M5B0DcxQ&e=svqkY2

The link above will bring you to an Excel sheet with our gnatt chart. Within the gnatt chart you'll be able to see our subtasks and timeline for the upcoming deliverables, and the upcoming client meeting 3 milestone. For reference the deliverable and tasks are purple and the milestones are pink.