## Problem Statement

While traditional blinds or curtains work well enough. They require manual input and allow heat into a building and do not dynamically adjust throughout the day. An adaptive facade system which reacts to the changing of the sun's position, as well as desired shade and interior heating would solve these issues.

## Design Details

The facade we are building should use a modular design which is easily expandable. In order to reduce costs, the amount of electronics in it should be minimized and other measures should be taken. The design must use a temperature sensor to monitor interior temperatures and have some way of tracking the Sun as well. It must also have a way of adjusting to the user's desired parameters such as light or temperature.

## Design Specifications

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| **User Need** | **Specification** | **Metric** |
| Panels respond automatically to sunlight | Light sensor triggers panel movement | Response time is 2 seconds after light change |
| Ability to override automatic behavior | User preference settings (manual shut, dimmable mode) | At least 3 distinct modes available (auto, shut, dimmable) |
| Temperature regulation | Panels adjust based on indoor/outdoor temperature | Maintain indoor temperature within 2 °C of setpoint |
| Scaled prototype | Window-sized dimensions | 50 in × 36 in |
| Sustainable materials | Final build uses eco-friendly materials | Sustainable materials like recycled, natural, or low-carbon material content (No plastics) |
| User interface | Simple control panel, remote, or app | User friendly accessible settings or remote |
| Sensor accuracy | Reliable detection of light and temperature | 95% or more accuracy compared to calibrated reference |
| Power supply & storage | System operates independently | More than 8 hours operation without external power |
| Wiring & electronics | Safe and efficient internal schematics | Meet UL safety standards |

## Prototype Details

## A close up of a metal strip AI-generated content may be incorrect.A white rectangular object with a black stripe AI-generated content may be incorrect.

Figure 1.) Prototype adaptive Facade in open(left) and closed(right) position

The Prototype consists of three modules. First the control module which contains a single 25 kg servo. This is mounted to a 3D printed wall mount and uses a 3d printed spur gear attached to the horn. Second the panel modules which consist of a 7 cm wide acrylic panel. Two brackets which mount onto either end of the panel. These brackets have 6 mm steel dowels which slot into a wall mount which attaches above a window and into a wall mount that attaches to the bottom of a window. The top wall mount only has a position for the panel however the bottom wall mount has positions for both the panel and a spur gear which also rotates on a 6 mm dowel. This spur gear meshes with a spur gear integrated with the brackets in order to rotate the panel. To simplify. the servo attaches to a spur gear which meshes with the bottom mount of the first panel which meshes to a spur gear which meshes to the bottom mount of a second panel and so on and so forth. All gear ratios in the Prototype are one to one in order to minimize size and for simplicity. This also means that rotation in the servo is translated directly into rotation of the panels.

Figure 2.) Top Assembly Detail

Figure 3.) Bottom Assembly detail

## Project Timeline

We have completed the first portion of our goals being having panels that move according to light exposure. When the sun hits the sensor, the panels move to let light in and when there is no sun (or light exposure) the panels close shut. The next steps are having different panel settings for the users’ preference, such as keeping them shut when light is exposed to the panels, having a dimmable option so only some light could be let in, and finally considering temperature regulation. Once we make iterations to the current prototype on these desired functions then we can work on another prototype that is actually window sized, the dimensions being around 50 in x 36 in. When we have the prototype working to scale then we will build our final project out of our real intended materials.

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| Date | Goals |
| Jan 23 – Feb 3 | Finalize inputs and corresponding sensors |
| Jan 23 – Feb 10 | Finalize dimmable option |
| Feb 4 – Feb 17 | Finalize design plan to meet standards |
| Feb 11 – Mar 3 | Finalize temperature regulation |
| Feb 18 – Mar 3 | Finalize dimensions and sustainable materials |
| Mar 4 – Mar 17 | Build user interface |
| Mar 4- Mar 24 | Build window-sized prototype (50 in x 36 in) |
| Mar 18 – Mar 31 | Test and calibrate sensors |
| Mar 25 – Apr 7 | Test durability and performance |
| Apr 1 – Apr 14 | Finalize power supply storage |
| Apr 8 – Apr 15 | Order final materials |
| Apr 15 – Apr 21 | Design wiring schematics for internal electronics |
| Apr 20 – May 7 | Assemble final smart facade window system |