# Problem Specification

Glass has fast become a very common building material for a wide variety of reasons including cost, safety, and aesthetics. One of the problems, however, with use of architectural glass is its reflective and transmissive properties when it comes to sunlight. Glass use creates an issue of allowing or directing sunlight into places where it may not be desirable; either inside or outside the building. This project aims to address the need for a simple and elegant approach to obstructing sunlight autonomously – only when it is unwanted. Fixed shades have a disadvantage of blocking light and obscuring sightlines permanently. Our design must have periods where there is little or no obstruction of the window. Computer controlled blinds can open and close at suitable times but have the disadvantage of being complex and expensive. This makes them less practical in single-family homes where the cost and hassle of installation and maintenance do not make sense.

The main issue faced in this project is determining what would be used to actuate the blinds. Given our limitations, the system must be able to independently detect and react to different levels of light throughout the day. The actuator must also have sufficient power to open and close the blinds. The preferred solution would not require an external power source to maximize convenience. This means the system must either be self-powering (solar or some variation) or battery powered. In either case the amount of energy expended in actuating must be rather small. This means the blinds themselves should require minimal work to open and close.

The two actuator solutions we’ve chosen to examine in this project are bi-material and shape-memory actuators. Both of these systems combine temperature sensing with actuation, meaning they are both triggered to actuate by temperature changes. This temperature change, however, must be tuned such that a temperature corresponding with direct sunlight is enough to cause a response while a cloudy day generates little to no response. The response generated by these actuators must also be enough to open and close the blinds. If it is determined that the change in temperature between sun and shade is not enough to create the required actuation an electronic system could also be considered where a current heats the actuators. In this case the electronic system will need its own way of differentiating sun from shade.

The shades must also be robust enough to function over multiple years without requiring significant maintenance. It should not degrade under UV light nor in high or low temperatures. The location of the blinds will have a large effect on what conditions are expected during operation. The harshest conditions would be experienced outside and the most controlled conditions would be between the window panes.

The goal of all these window shade installations is to improve the passive cooling ability of a building. The systems all slow the rate of heat transfer into a room via the windows. The shades will either be standalone or run alongside an active cooling system like air conditioning. Thus the system must have a significant impact on reducing the cost of cooling the room. The blinds cannot be too expensive to ensure overall cost savings.