# MSc Computational Architecture
Crafting Systems UBLLX1-15-M | 2022-2023
Natural Light to the North Facade

Ben Irons & Benedict Starling

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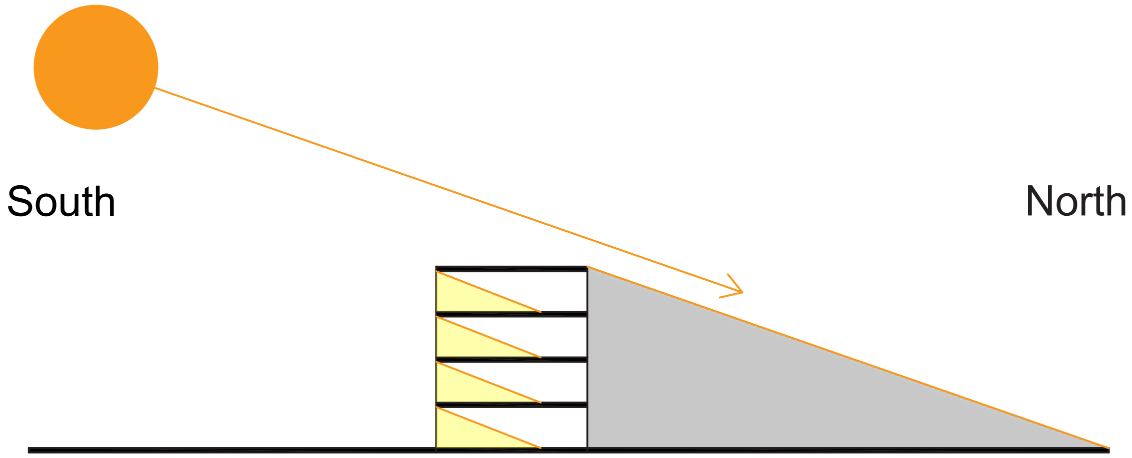
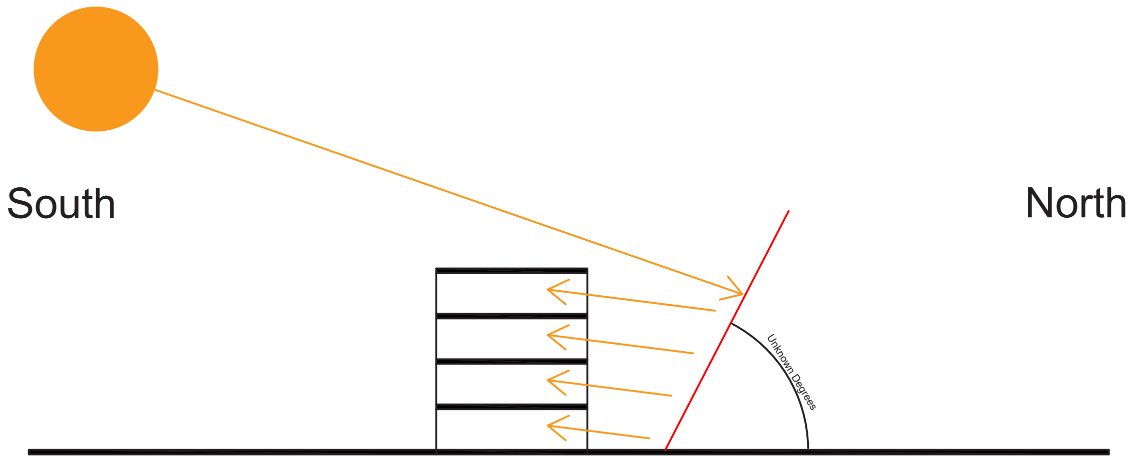
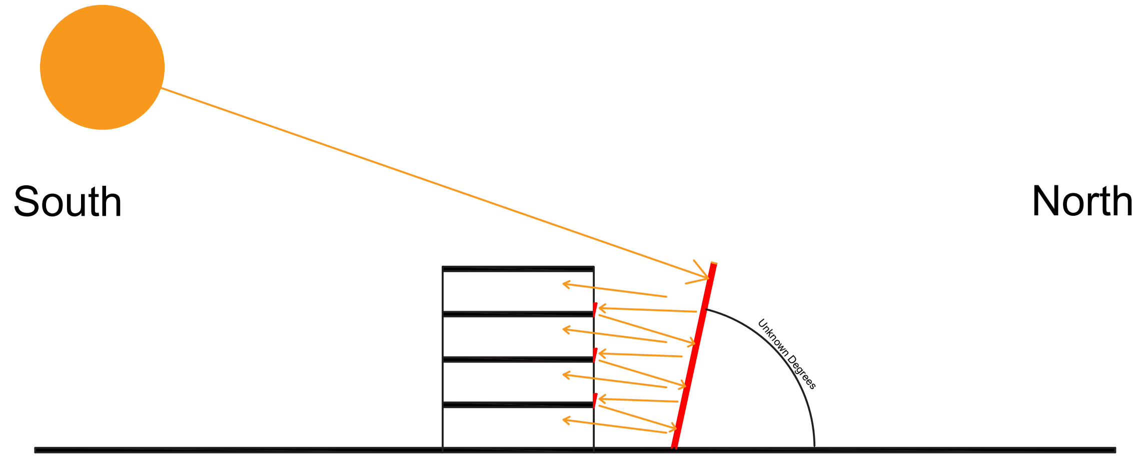
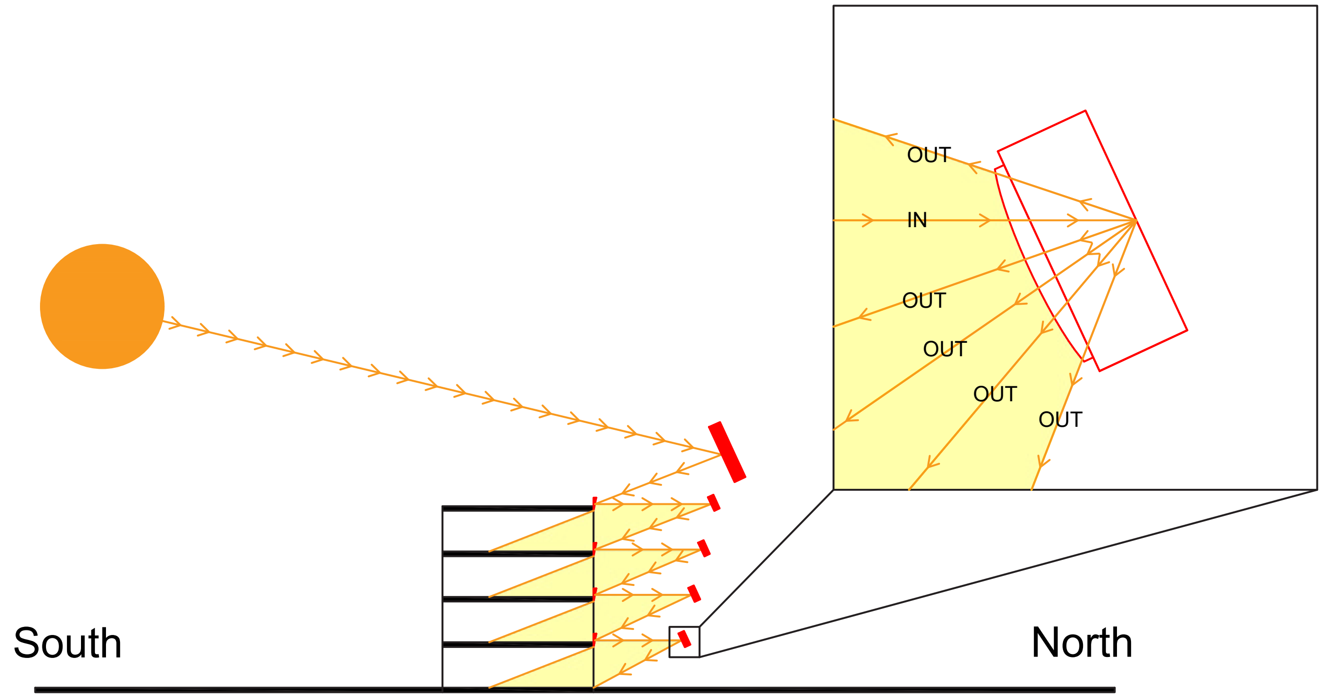
# Research and first ideas

This project will look at how to increase the amount of Light on the North side of Building in North and Arctic conditions.  Focusing on the Shaded North face of buildings typically receive little to no solar gain, in these areas.  This study will look at way to combat this but designing a Façade that can reflect light coming from the south on to the North side. The images above shows the early ideas for the project regarding reflecting the Light in to the building.

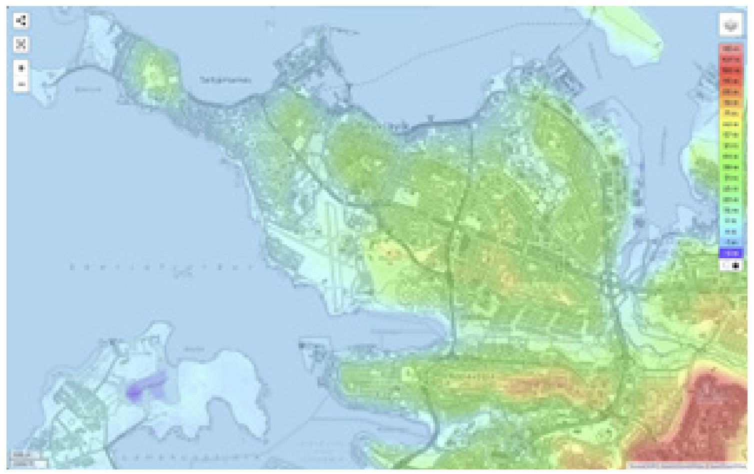



This project will use the City Reykjavík which is in Iceland as its location as an example of a city in a Arctic climate.



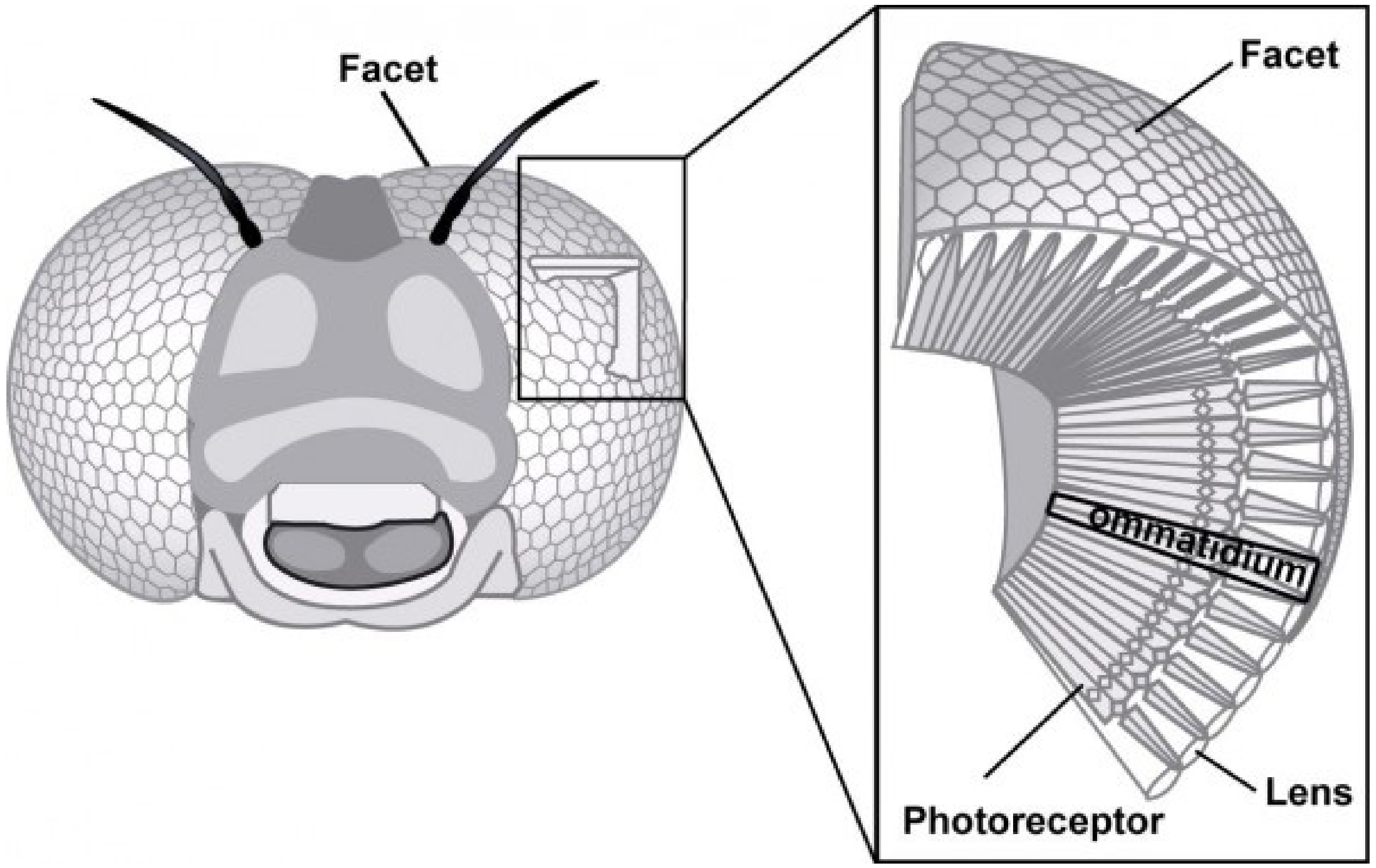
64° N, world's northernmost capital, pop. 131,000.

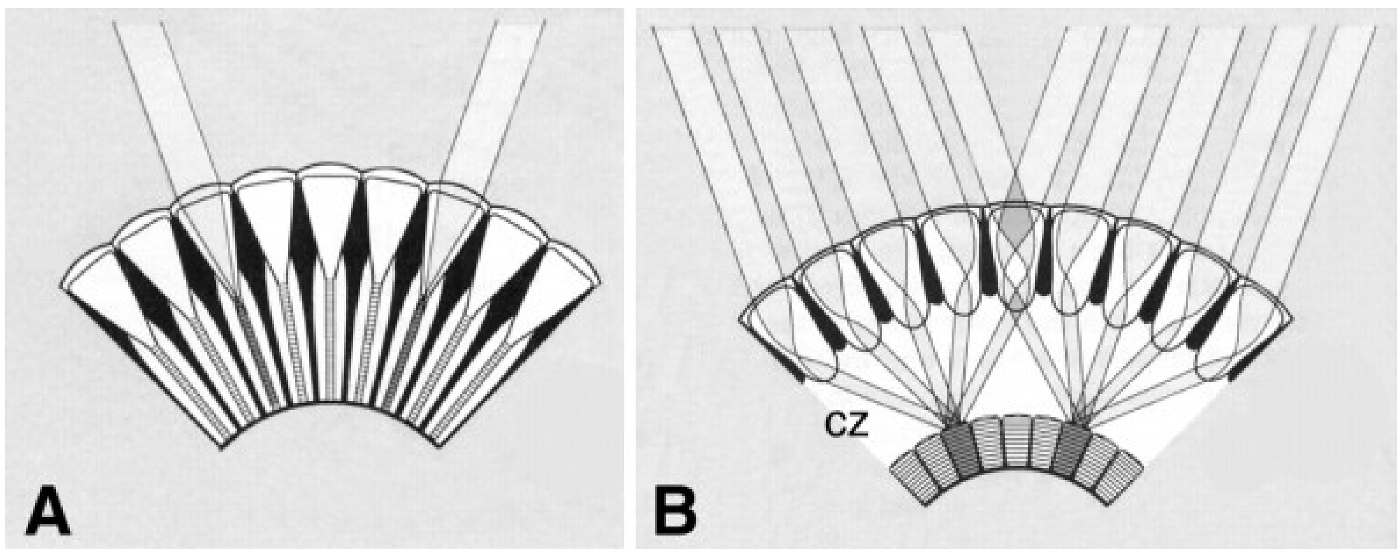
Min 04h08m daylight @ 19-24 Dec

Max 21h08m daylight @ 21-22 June

Coastal City – altitude between 0 – 85 m above sea level

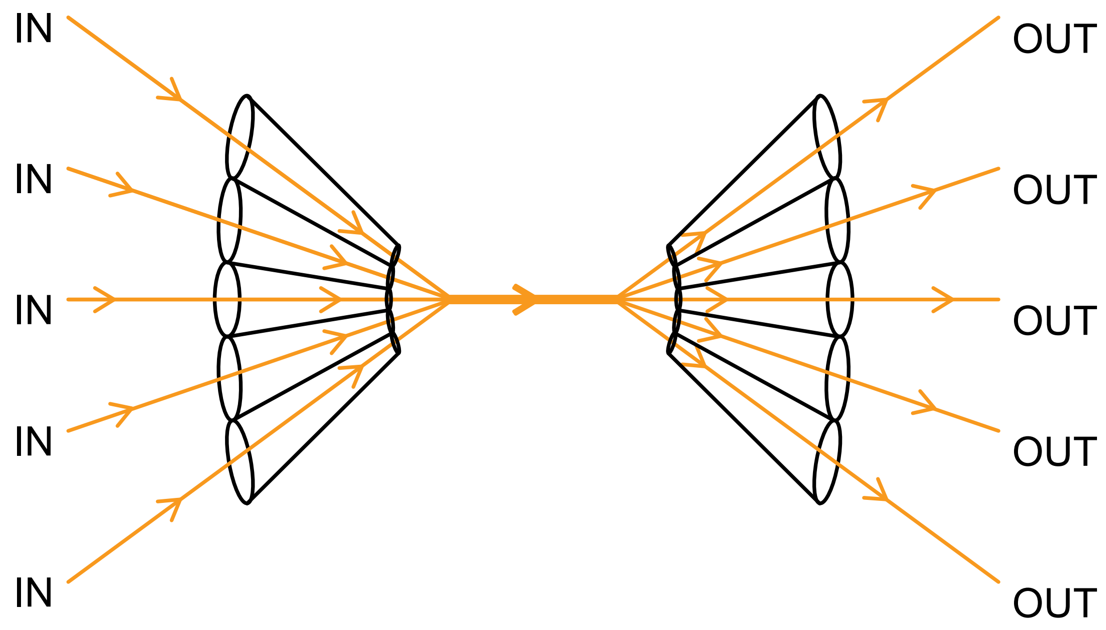
https://en-gb.topographic-map.com/map-6p23q/Reykjavik/?center=64.13133%2C-21.92257&base=2&-zoom=13&popup=64.1302%2C-21.90302

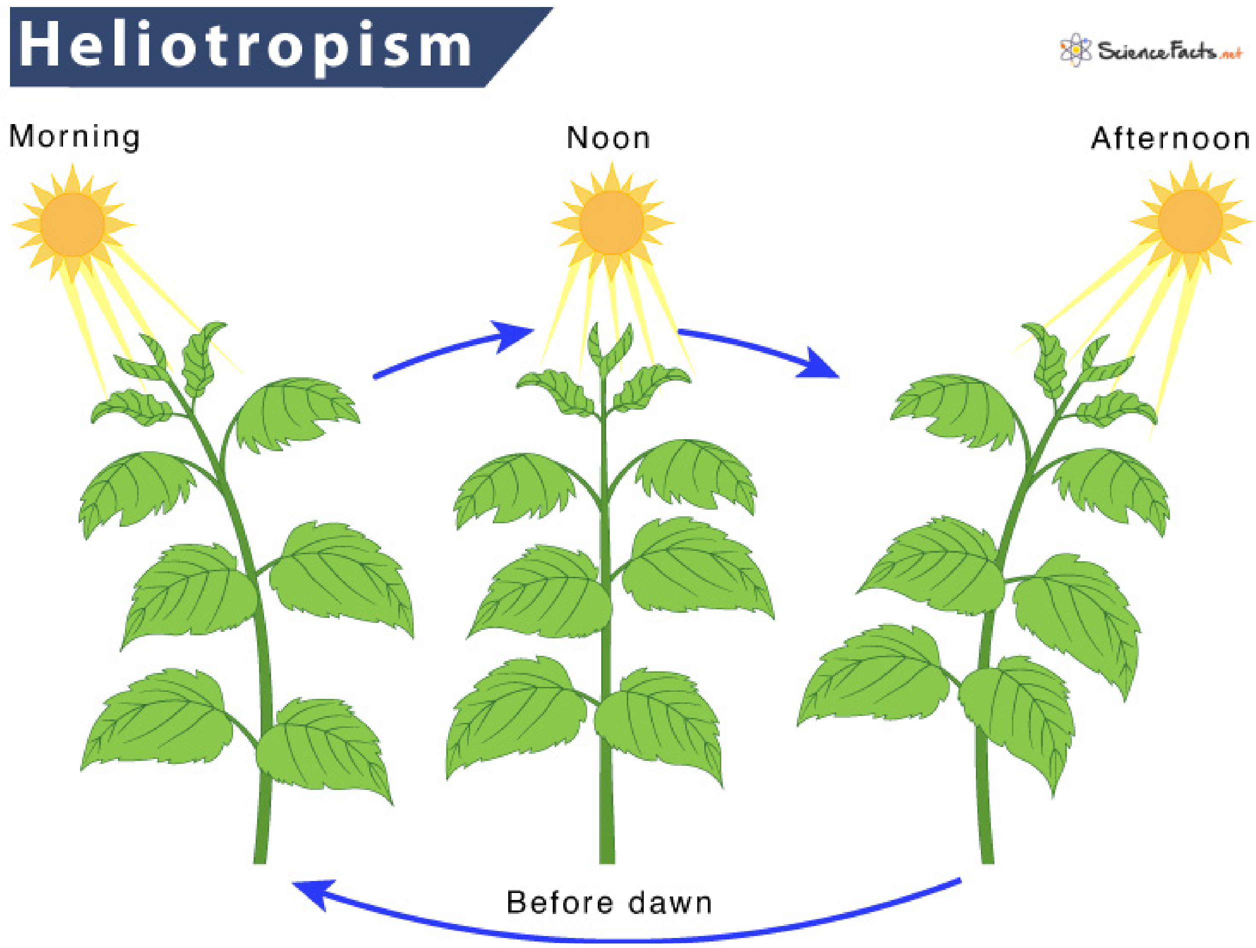



https://passion-entomologie.fr/vision-in-insects-part-1-anatomy-and-structure-of-compound-eyes/

Looking at Natural inspiration the eyes of Insects with compound eyes had a solution that could be adapted to buildings facades.
The function of the eyes is to receive and guide light energy (photons) to specialized receptor cells. Unlike a human eye the Insects takes the light from multiple sources to a specific point. This processes can be use in both collecting the light and intensity it to a specific point and in reverse to spread the Light over a desired area.



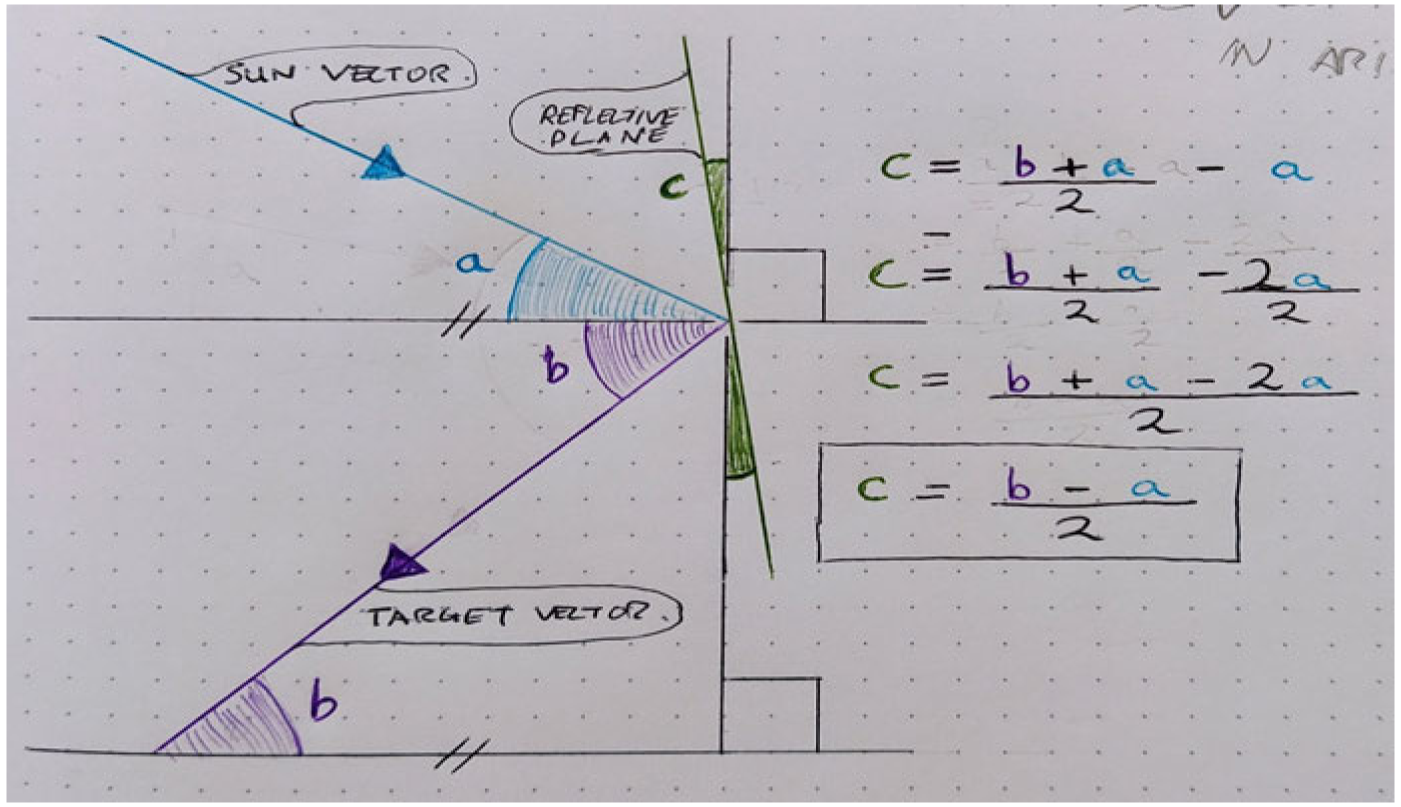

https://www.sciencefacts.net/heliotropism.html

Some flowers slowly track the sun's path across the sky from dawn to dusk. The sunflower is considered the most common example of a heliotropic flower.

https://www.theatlantic.com/photo/2013/10/using-giant-mirrors-to-light-up-dark-valleys/100613/

The villages of Rjukan, Norway, and Viganella, Italy, are both situated in deep valleys where mountains block the sun's rays for up to six months every year. To illuminate those darker winter months, the two towns have built gigantic mirrors that track the sun and reflect daylight downwards. Viganella completed its huge computer-controlled mirror in 2006, and Rjukan followed suit just this month, mounting a mirror that will reflect a 600 square meter (6,500 square foot) beam of sunshine into the town square below.

Main Aim/Function – Bring controlled Natural light into shade N face of building whilst not obscuring the view outward.




Why important – Bringing natural light or 'daylighting' is good for our wellbeing. Seasonal Affecting Disorder particularly affects people living in areas far North or South where people experience low levels of exposure to sunlight during the winter months. Additionally, daylighting reduces our dependency on artificial light sources, lowering the energy consumption of the building.

Main Problem project tackling – Redirecting variable levels and vectors of light towards surfaces within a constrained space claim. The redirected light must make sufficient improvement for the proposed façade to be feasible.

To maintain the angle (b) of reflection of sunlight towards the target (target vector), a reflective plane at angle (c) adjusts to the changing position of the Sun and subsequent angle (a), so that c = (b-a)/2.

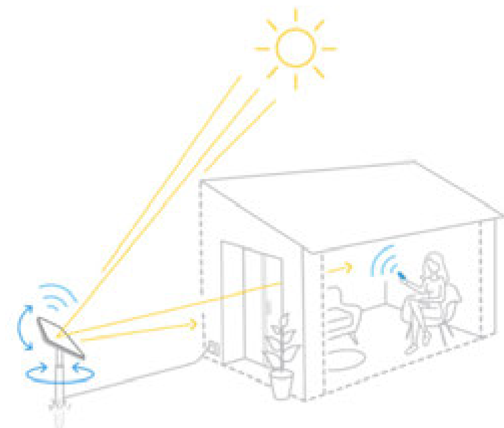
Utilizing the Ladybug Plugin's components for Grasshopper; the Sun Vectors for Reykjavik can be easily referenced using SunPath and multiple reflections using Bounce from Surface the Sun Vectors can be visualized and analysed with reflective geometries.

https://cdnassets.hw.net/dims4/GG/560d324/2147483647/resize/876x%3E/quality/90/?url=https%3A%2F%2Fcdnassets.hw.net%2F50%2F5b%2F5197b72e4a15975ec7389e0fe229%2Fsolarelectricnightlight-solatube.jpg

Tubular prismatic system redirects daylight through an acrylic dome lens into a reflective tube and provides illumination

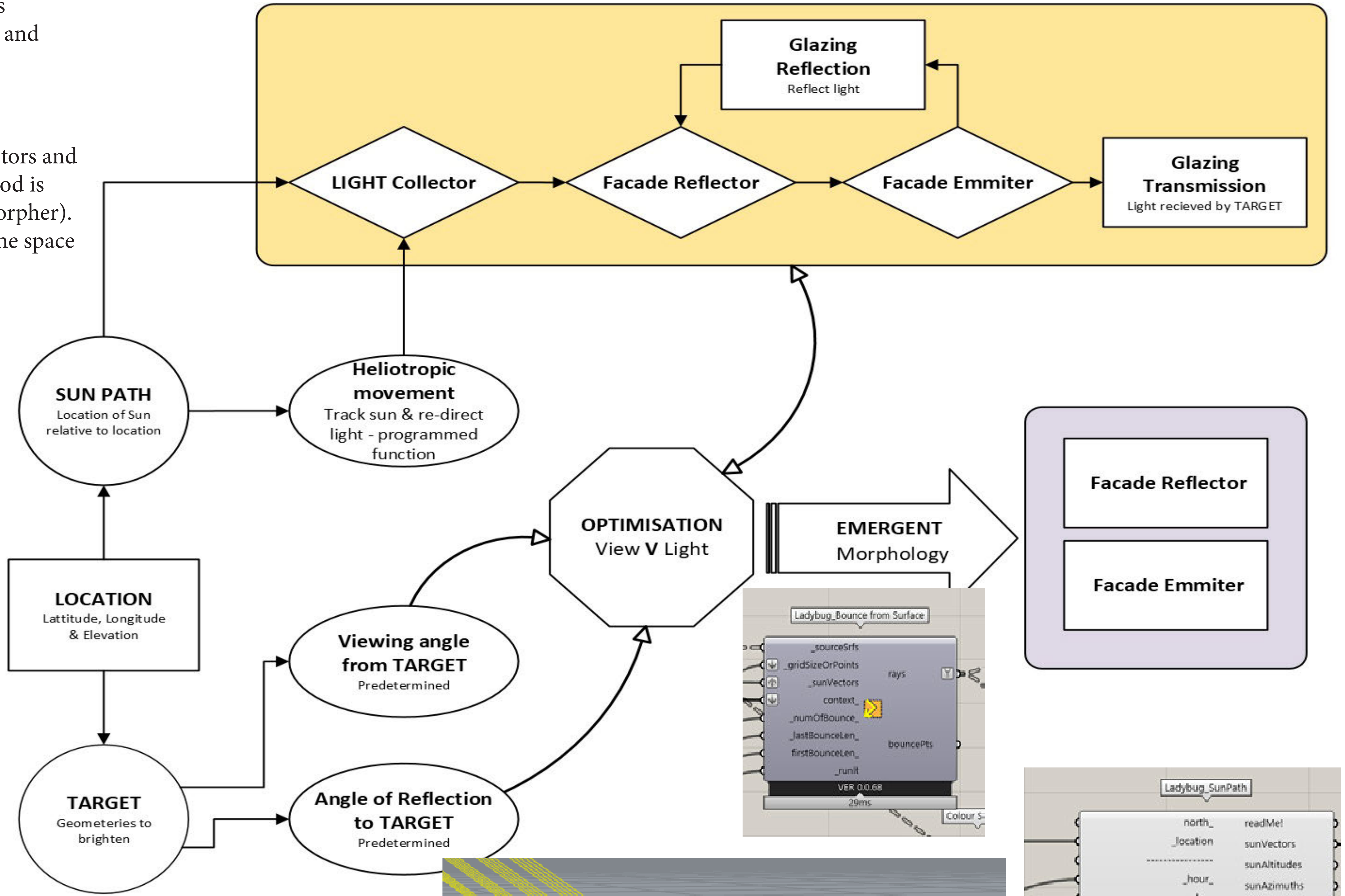
The image above shows an example of a Product available for home use for refecting light in to the home.

https://www.espaciel.com/blog/fr/maison-au-nord-comment-faire-entrer-les-rayons-du-soleil-chez-vous/



The above Flow diagram illustrates how the flow of light is transmitted through the façade system of; Light Collector and Façade Reflectors and Emitters.

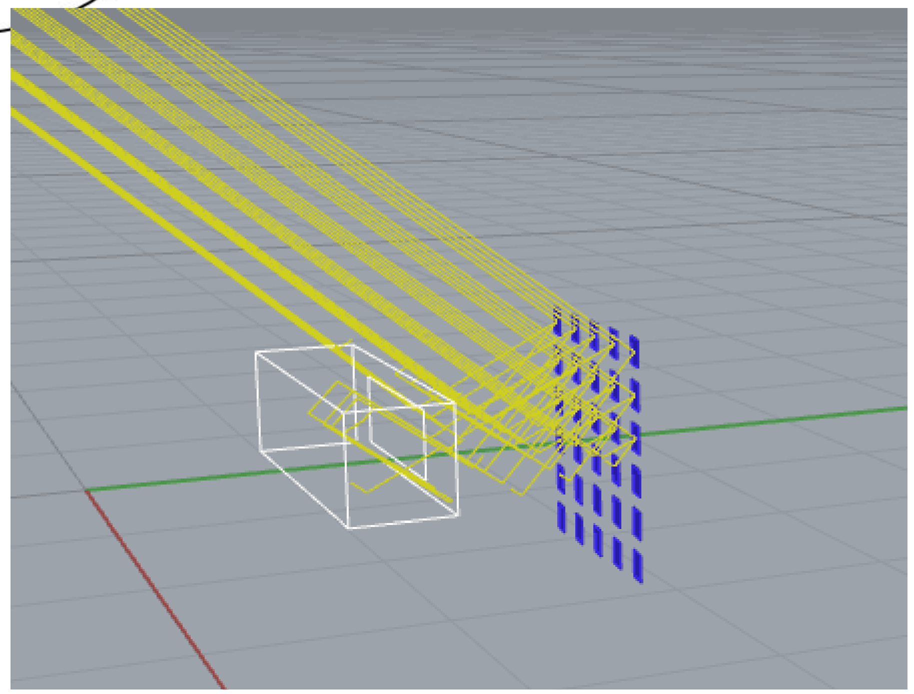
To instigate the emergent morphology of the façade reflectors and façade emitter's, a dual goal orientated optimisation method is proposed (using a genetic algorithm plugin such as Biomorpher). The viewing angle from the Target geometries constrain the space which the illuminating façade can emerge within.

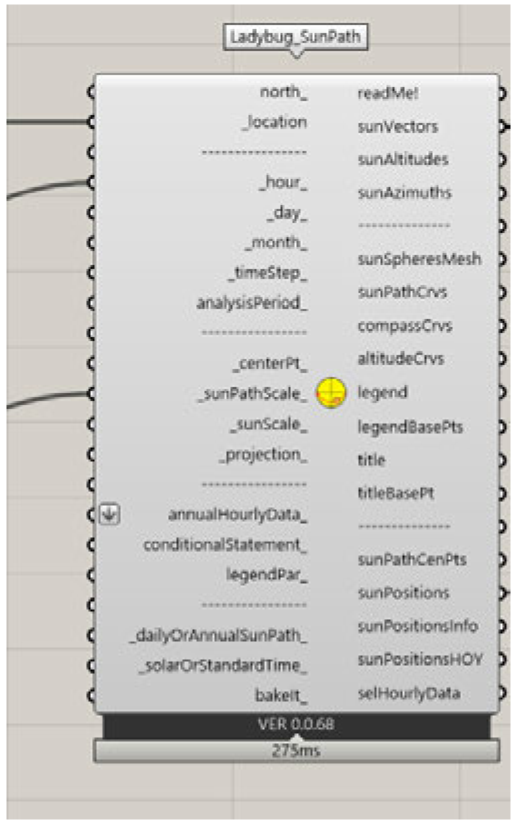



The morphology and arrangement of Façade reflectors and Façade Emitters could take further inspiration from that of plants which avoid self-shading such as cat mint.

The next step of this project will be to ruin grasshopper tests. At this stage a couple of test were completed using some of the Components from Ladybug, This included the location of the Site in this case Reykjavik, The sun path and Bounce from Surface Component. The out put of this can be seen in the Image above.

The next steps will be to look into how to create the best shape using this data.





# Precedent studies of daylighting facade systems

In 'Bio-inspired responsive facades' (Jong Jin and Bharat, 2013), they develop a proposal for a daylighting responsive facade which covers the roof of a stadium in tapered tube components which house reflectors which direct the sunlight to improve daylighting within the stadium. The assembly of tapered tube components are derived from structure of compound eyes.

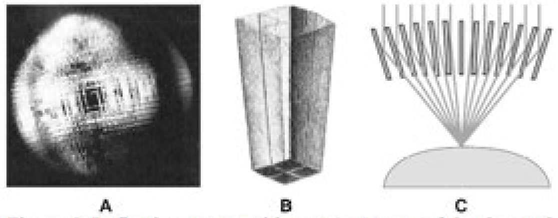


Figure 6. Reflecting superposition eyes: (a) eye of the decapod shrimp, (b) tapered mirror box in a shrimp drawn by Grenacher in 1979, (c) cross-sectional schematic of reflecting superposition eyes.

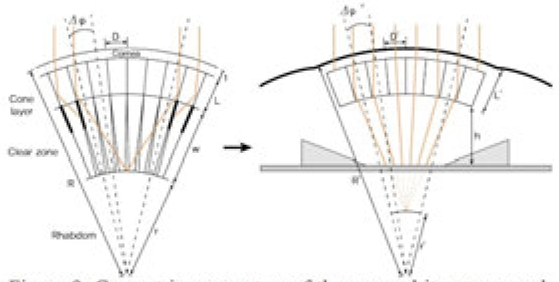


Figure 9. Geometric parameters of the eye and its corresponding conversion into architectural form.

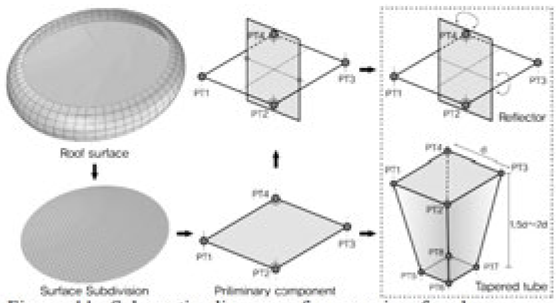


Figure 11. Schematic diagram of responsive façade components.

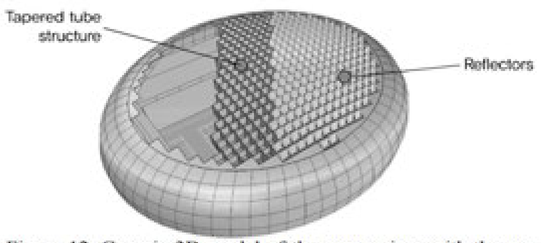


Figure 12. Generic 3D model of the gymnasium with the proposed roof system.

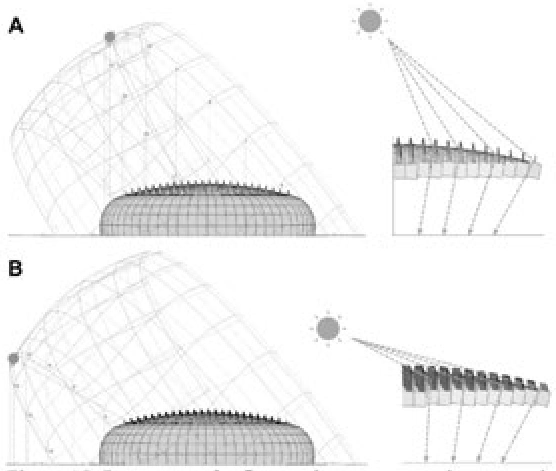


Figure 15. Responses of reflectors in response to the sun position during the summer (a) and the winter (b) time.

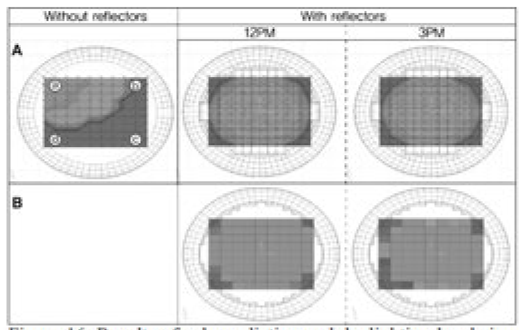


Figure 16. Results of solar radiation and daylighting level simulations with and without responsive reflectors.

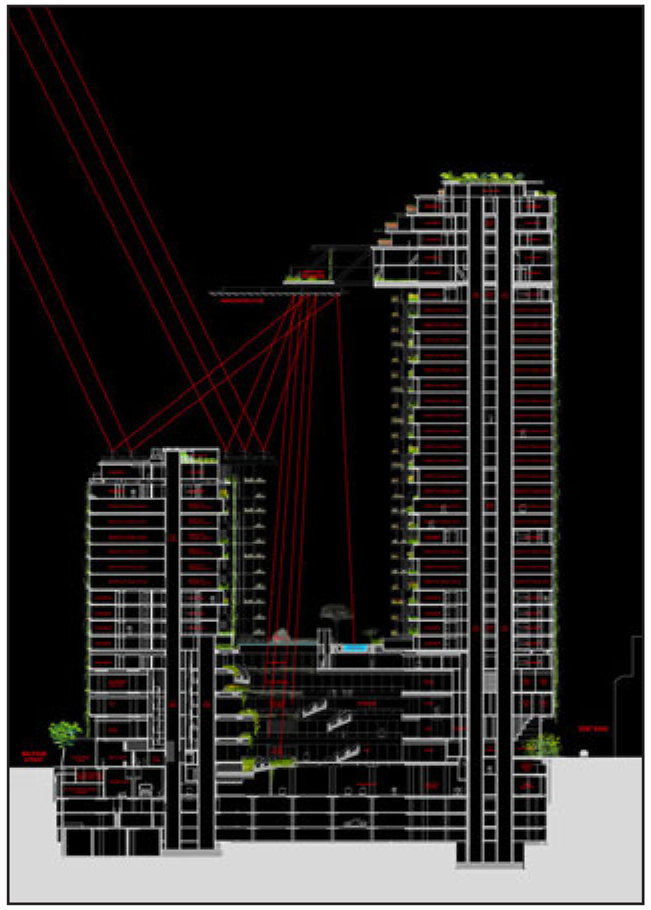
Table 1. Node values at the centre and four corners from solar radiation and daylighting level simulations.

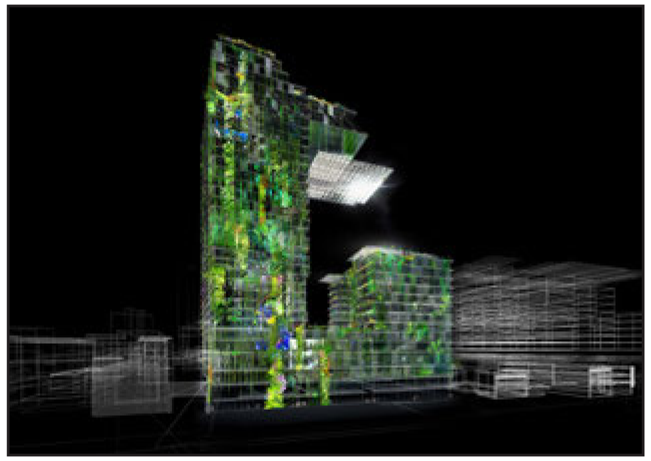
| | | Without reflectors | With reflectors 12PM | With reflectors 3PM |
|---|---|---|---|---|
| Solar radiation (Wh) | Centre | 18.93 | 95.96 | 33.83 |
| | Corner a | 25.55 | 68.88 | 23.57 |
| | Corner b | <1.00 | 74.47 | 25.19 |
| | Corner c | <1.00 | 68.98 | 24.37 |
| | Corner d | <1.00 | 68.86 | 24.18 |
| Average daylighting level (lux) | | | 6,369.81 | 6,341.90 |

(Jong Jin and Bharat, 2013)

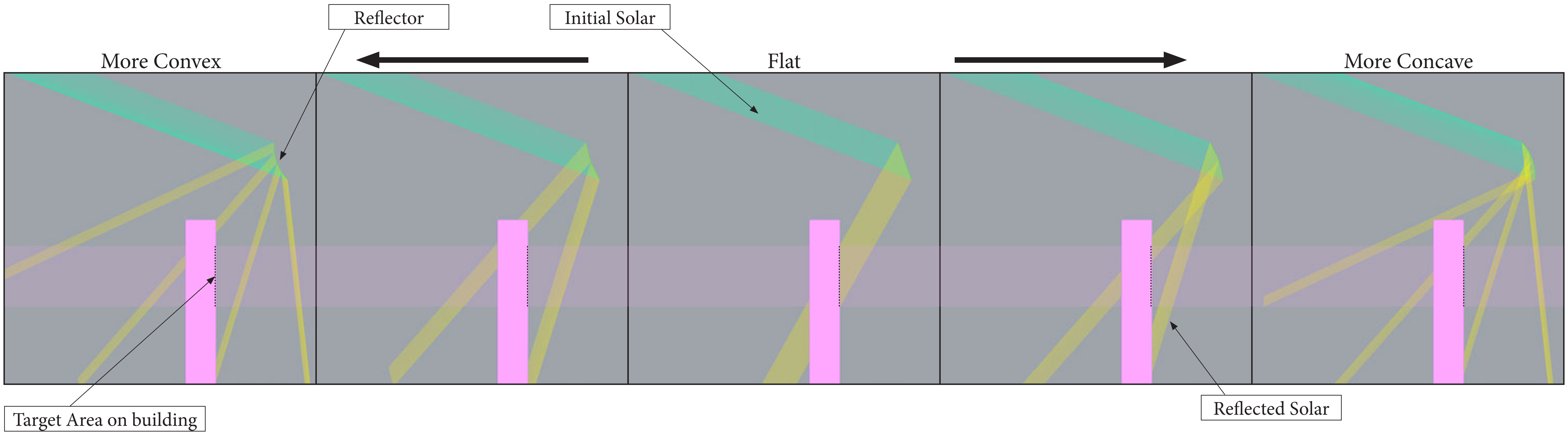
One Central Park by Ateliers Jean Nouvel Architects completed in 2014. The cantilevering assembly of motorised mirrors capture sunlight, and direct the rays down onto Central Park's gardens.

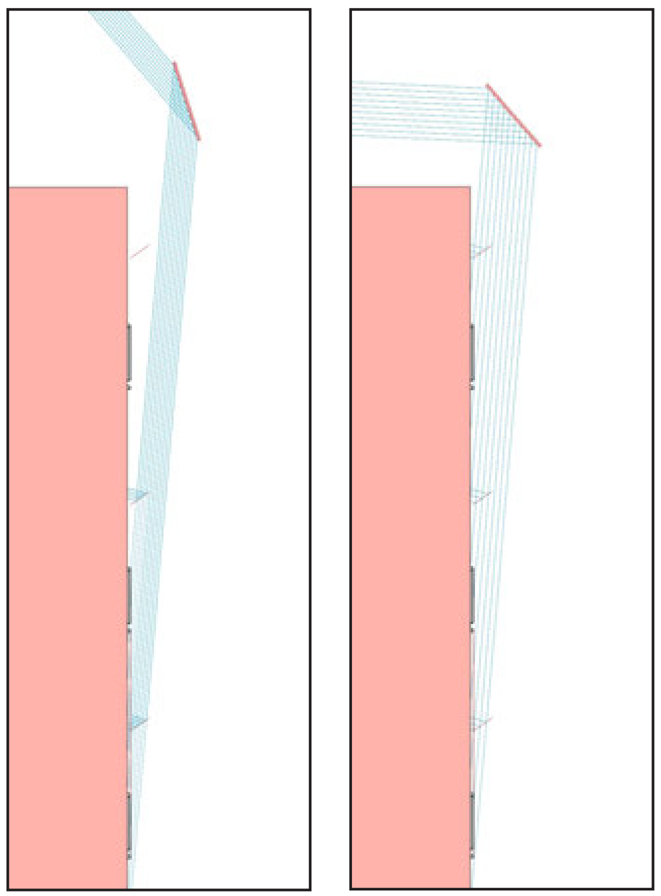
(Saieh, 2014)





# Initial study of Convex, Flat and Concave Reflector



The target area on the building (pink rectangle) is where the faint pink strip passes through the buildings and is represented by a dotted black line.

The Flat reflector (c) performs best because the light vectors are more consistently and repeatably directed towards the target.

An adjustable convex reflector could help spread light to the target, however subtle changes in curvature can have big changes in the reflected light vectors. Potentially, multiple flat reflectors at incremental angles could have the same intended effect but be more feasible.

Concave reflectors have the effect of focusing light to a point which carries the severe risk of fire, it also performs similarly to convex reflectors in dispersing the light. For the severe risk of fire, Concave reflectors should only be considered for further development if a focussed source of light is an absolute fundamental requirement for daylighting purposes.

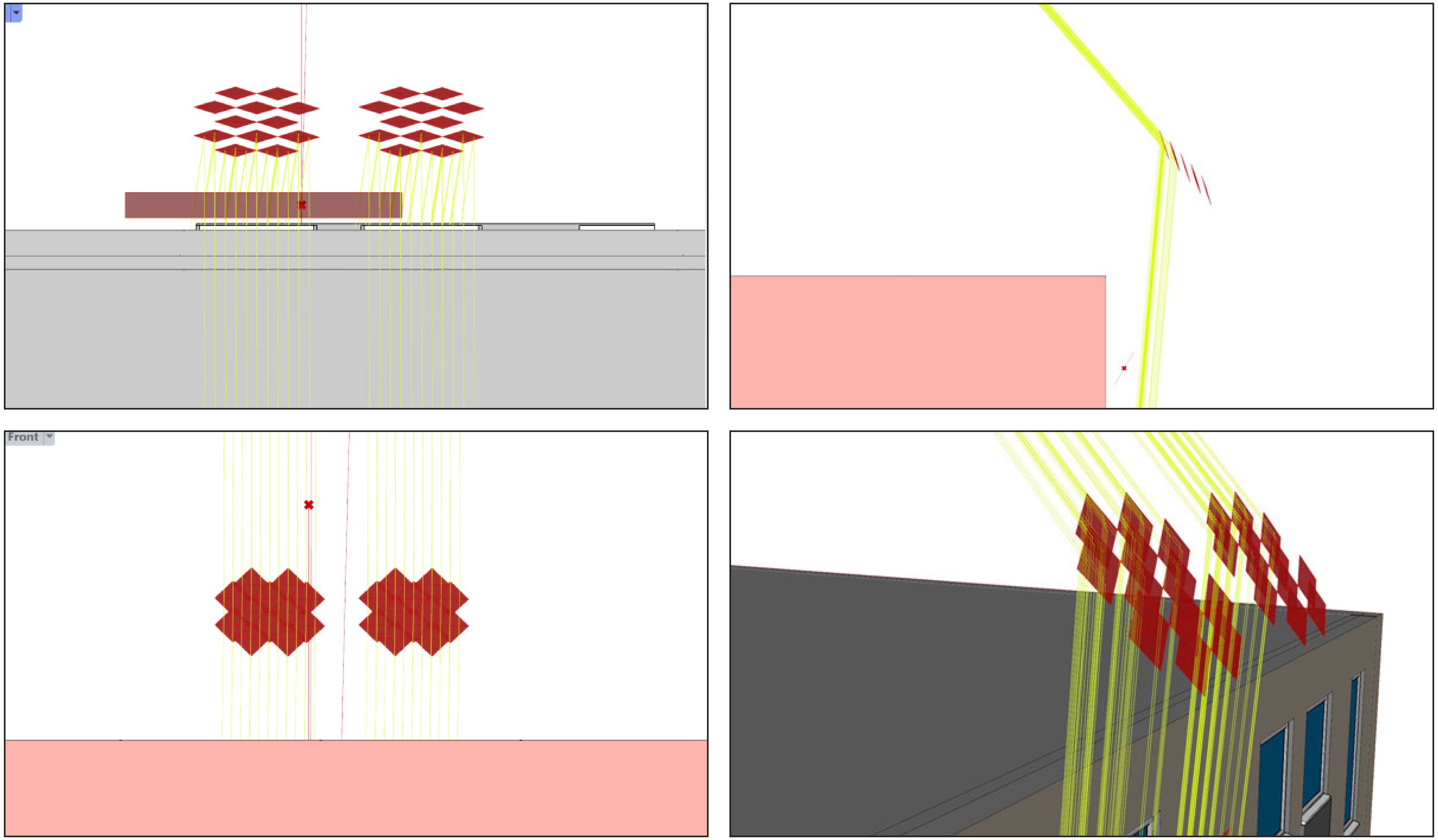
## Sunlight not reaching the target

Working with Flat reflector and developing it into a system, as seen left, the re-directed sunlight covers the secondary reflectors sufficiently when the initial solar angle is low in the sky (winter) yet does not cover them all when the angle is higher (summer). A development on this point is required to ensure there is always sunlight reaching the target during daylight hours throughout the year.

# Initial Reflector option - Diamond Array

Taking inspiration from plants such as Catnip (right) which orient their leaves so as to reduce self-shading, below shows a study of Diamond Array of smaller mirrors which retain a position closer to intended target beam.

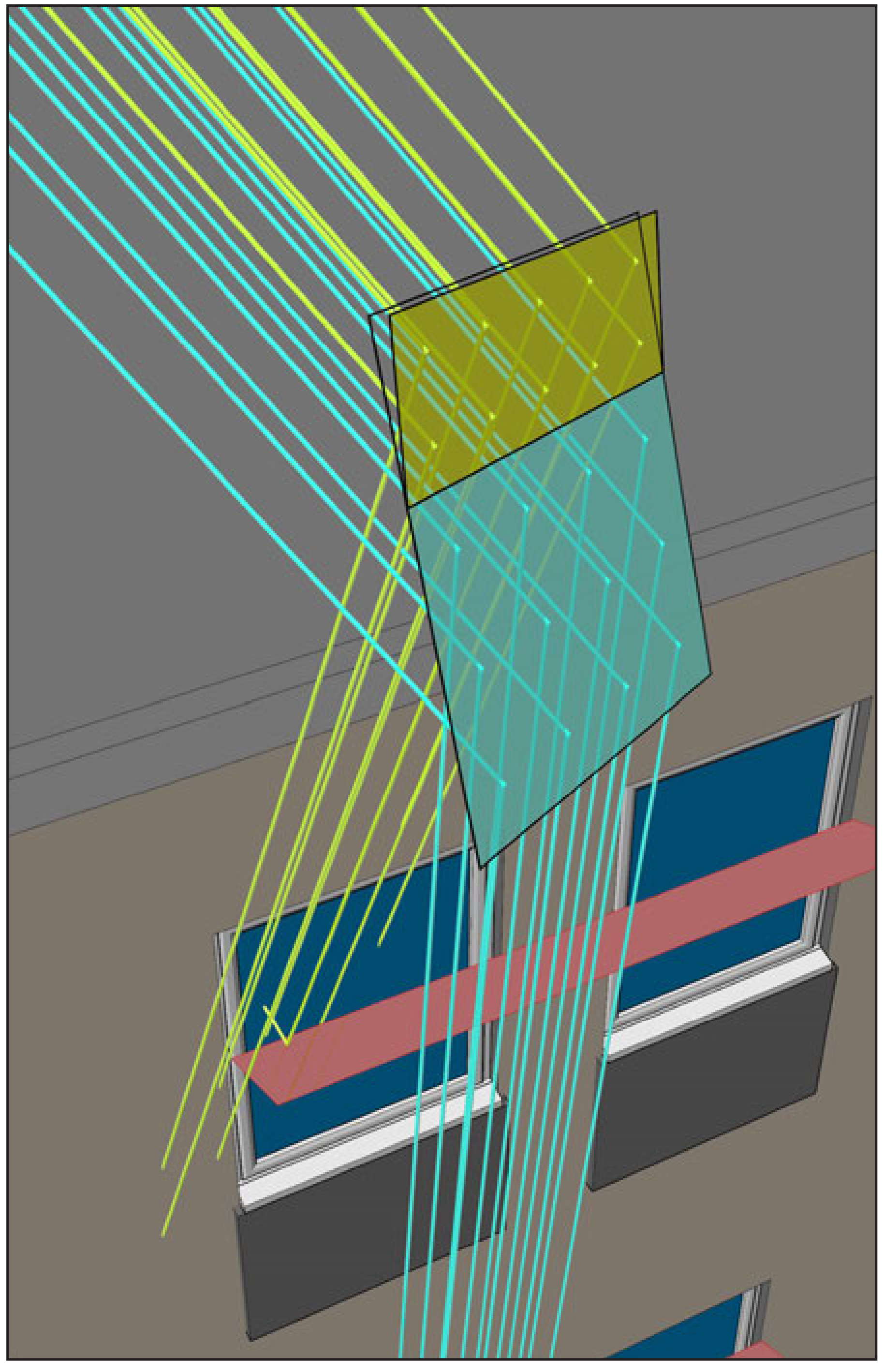
A lot of self-shading  of the mirrors at different Sun locations throughout the year reduces effectiveness of this proposal.  However further development could generate a formation which is effective.

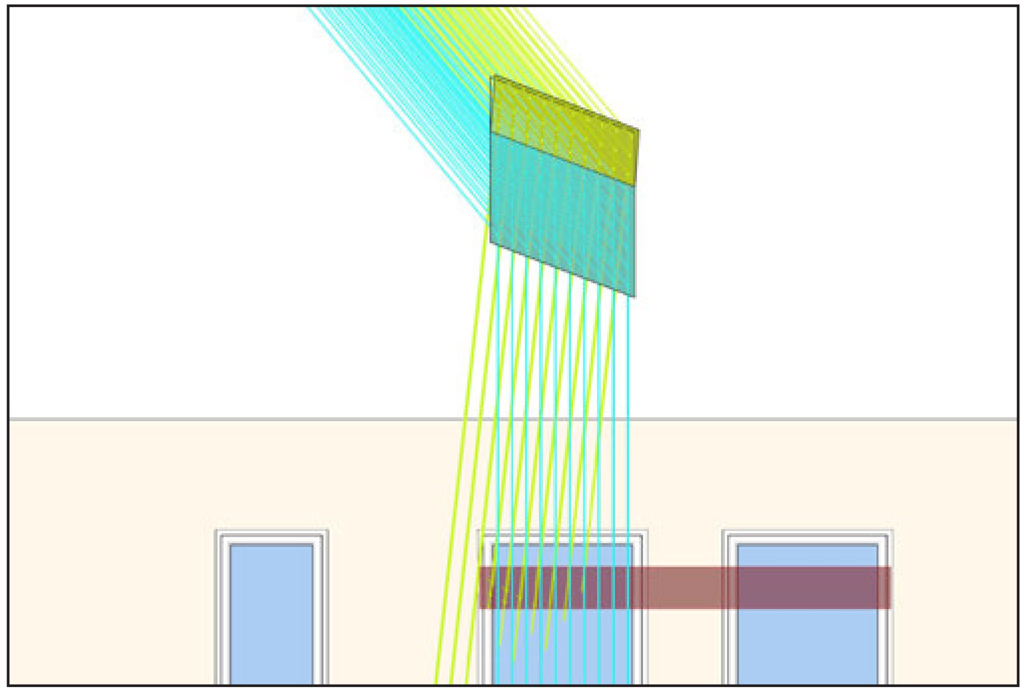


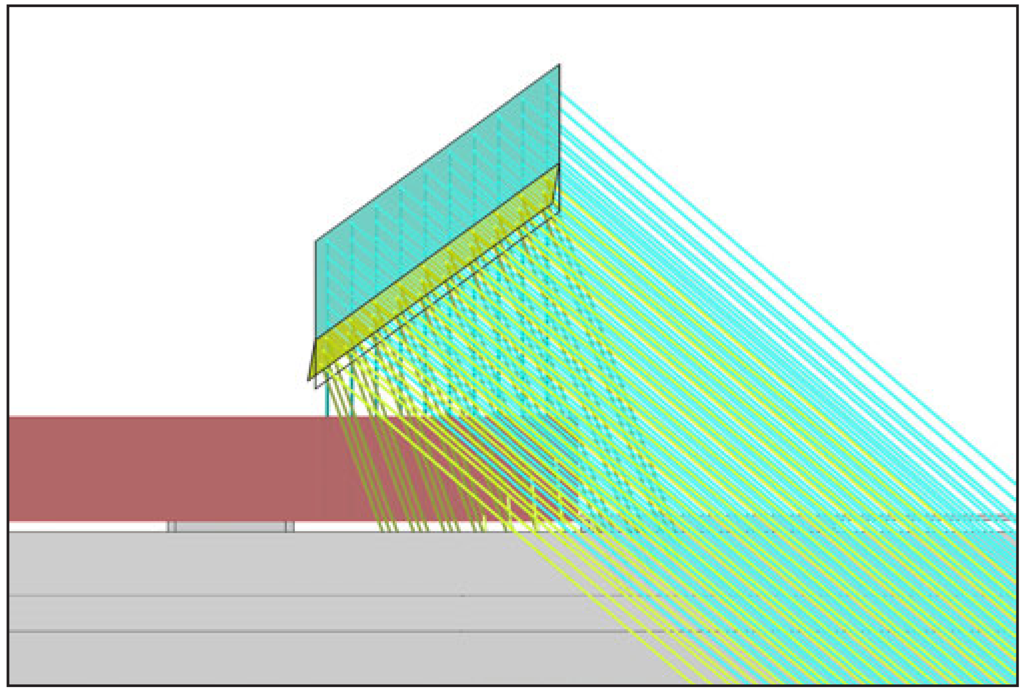
# Initial Reflector option - Adjustable multi angle

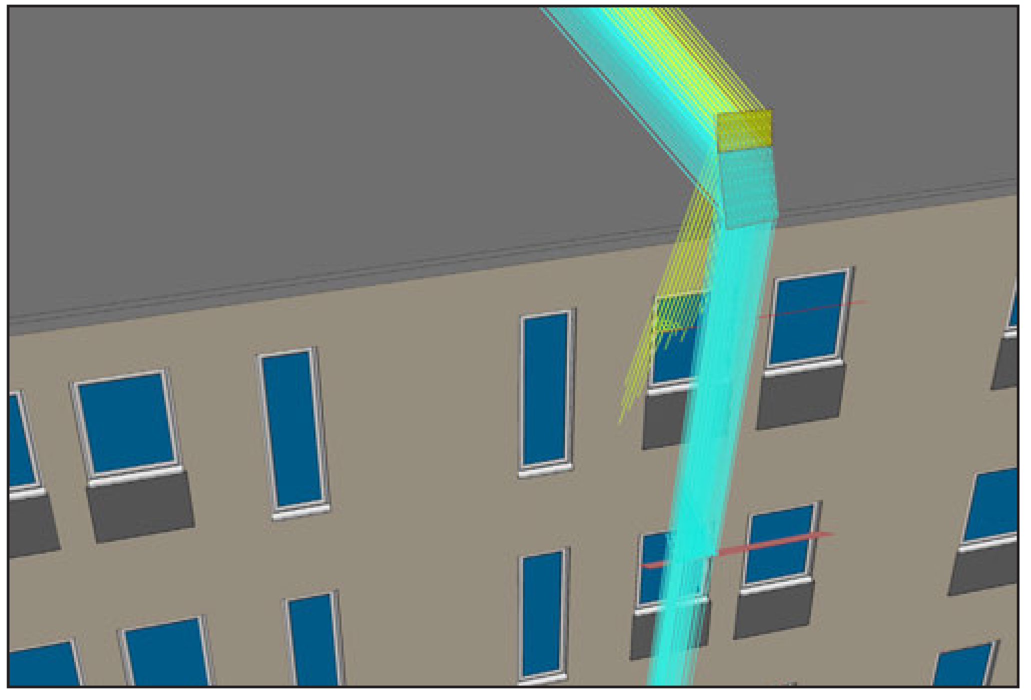
Taking inspiration from plants such as Bracken (right) which appear to spread and articulate their leaves , below shows a study of an adjustable multi angle mirror which re-directs the top rays (yellow) at a steeper reflection angle to reach the target when looked at side on from the target.

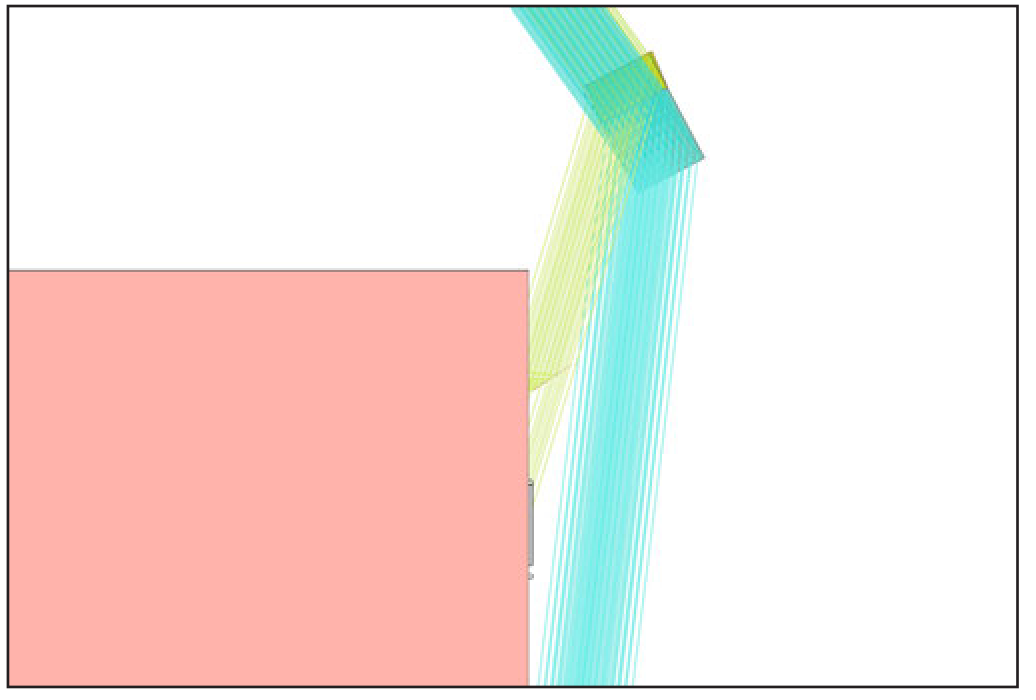
However when pivoting the top fold of the mirror, reflected rays are skewed from target beam, when looking from above. A more complex assembly where each fold also has its own yaw rotation could work but could become a very complex and delicate geometry to manufacture and make reliably operable.







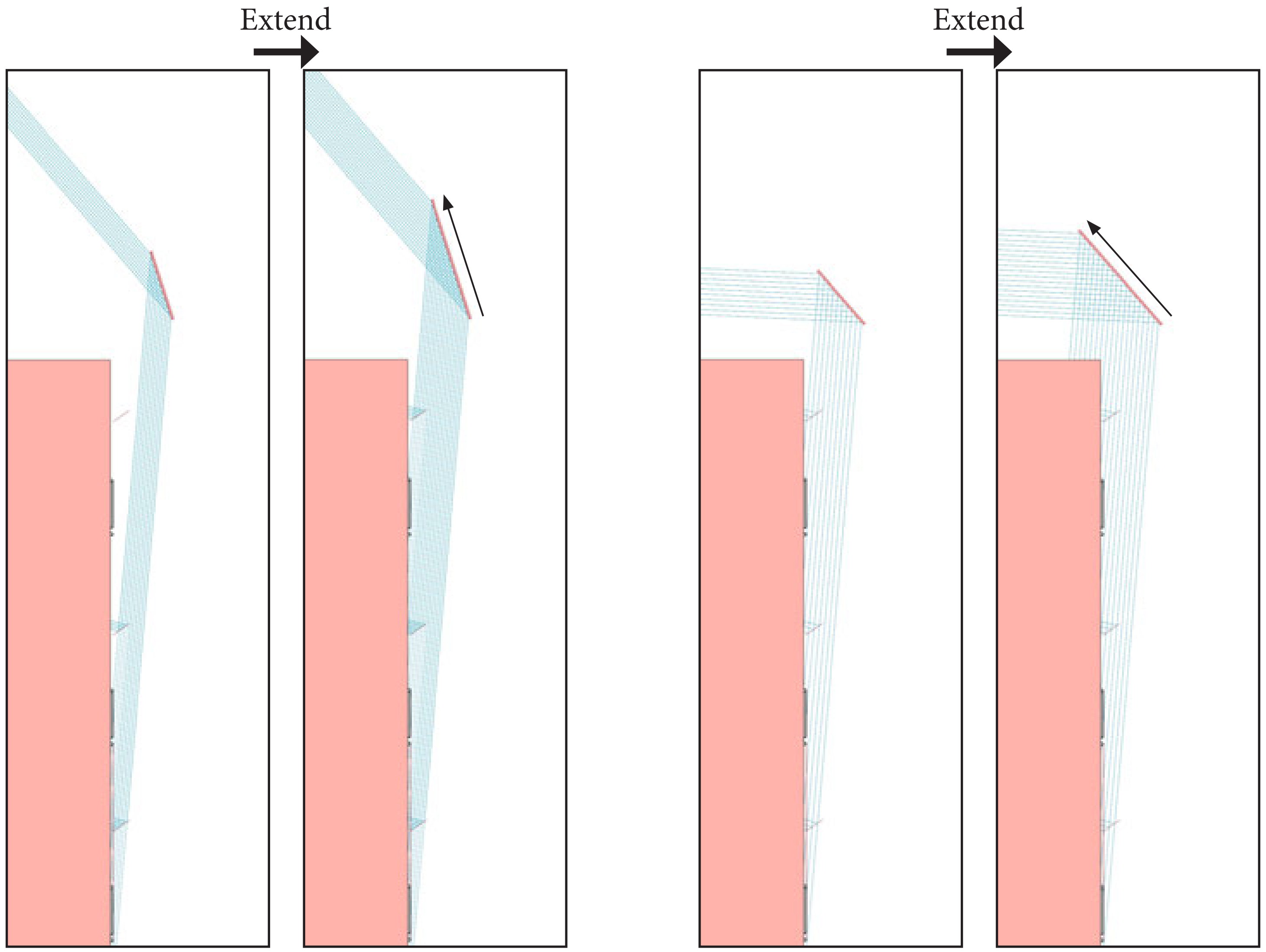




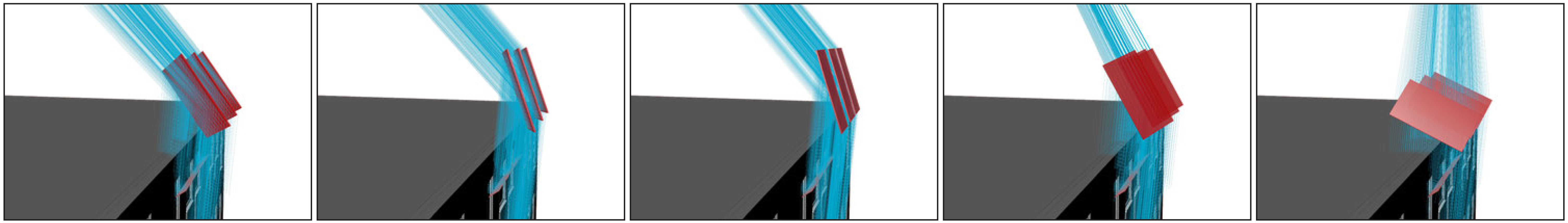
# Initial Reflector option - Extended Flat Mirror

Classically Heliotropic Plants such as the Artic Poppy (below) track the sun with individual flower heads. Alongside sunflowers, they have proportionally large flowers to the rest of the plant. Understanding this, simply extending the length of the Flat Mirror has the effect of covering the Target Beam close to all of the sun positions throughout the year.

At close to horizontal pitch angles some of rays reflected from the top of the mirror are wasted onto the top of the building, however extending the mirror material would be considerably less complex and costly than adding multiple interdependent componentry than the other 2 options.




Extended mirror throughout the day (21st June), reflected sunlight always reaches target despite some lost to top of building at either end of the day.



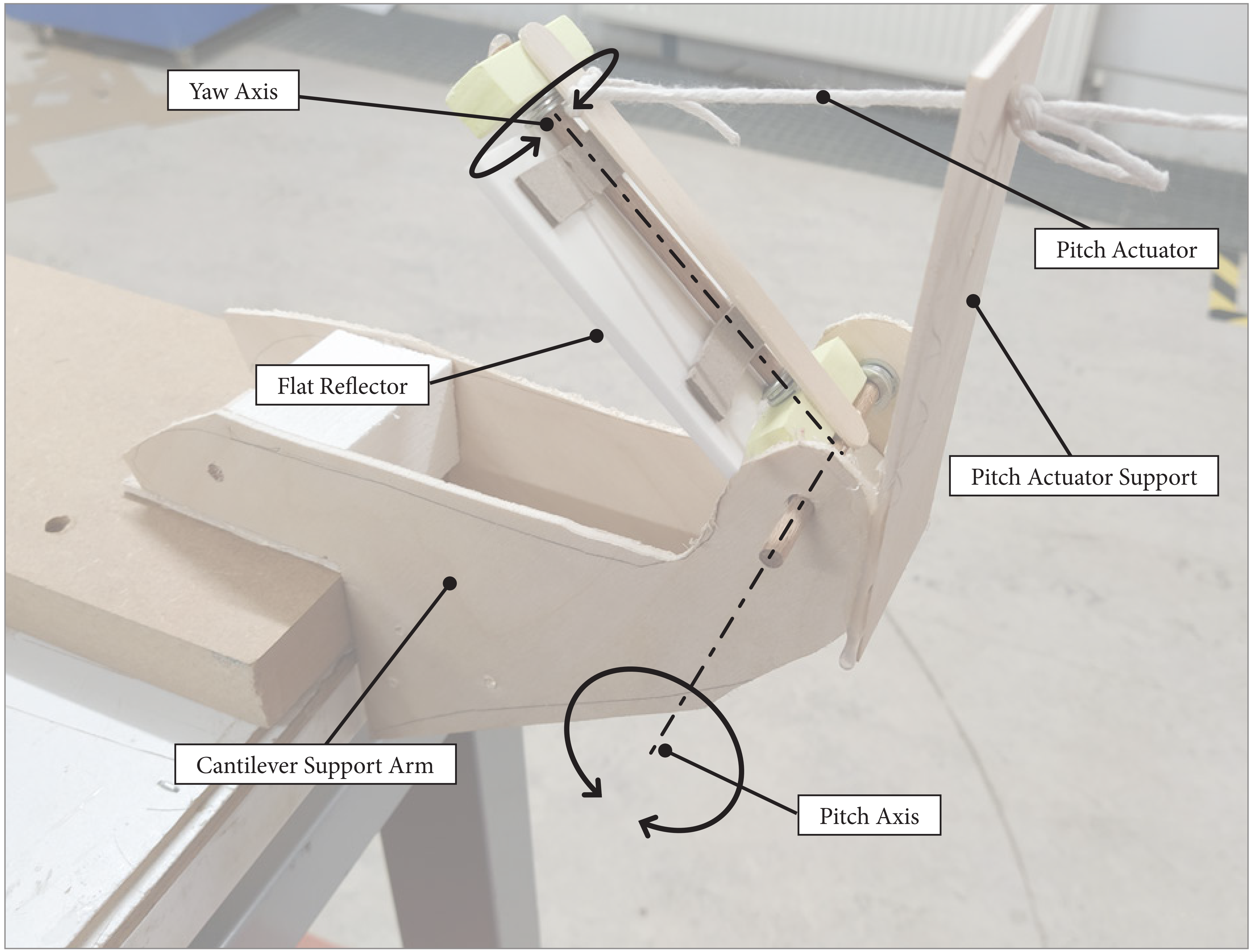
# Sketch Modelling

Sketch modelling allowed a system to be quickly evaluated and semantically understood, where the top and edge of the table simulates the top and side of a building. Through its assembly, parts need adding, removed and altered so that the desired function operates as intended.

The model developed is the flat reflector which has 2 axial degrees of movement as illustrated by the dashed lines below.

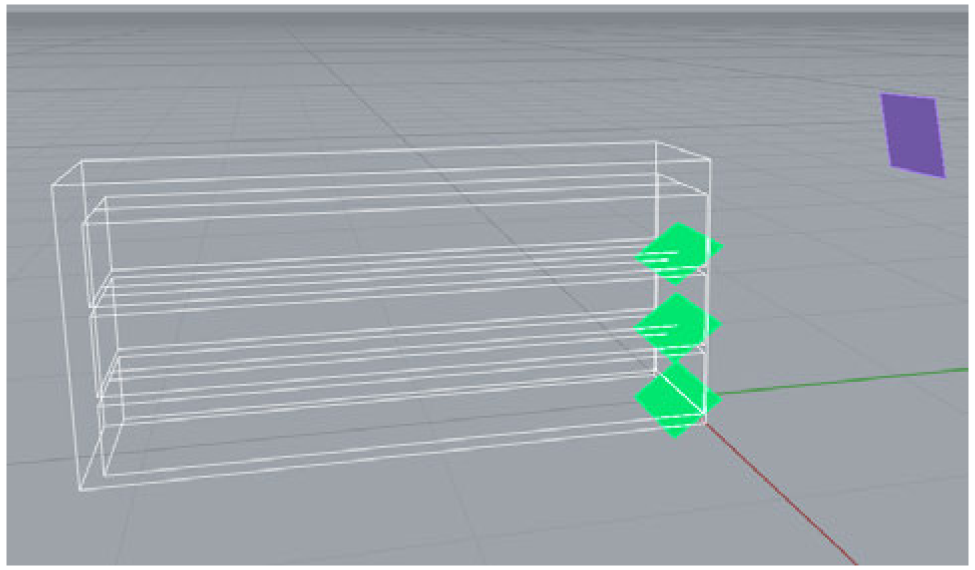
The reflector directs light from the light source down towards a target as shown below (camera is light source, face on cube is target). The cantilevering support arms modelled with thin plywood, when looked at in the reflection, show that only the thickness of the support arms are shown meaning only a minimal loss of reflected light towards the target from shading.

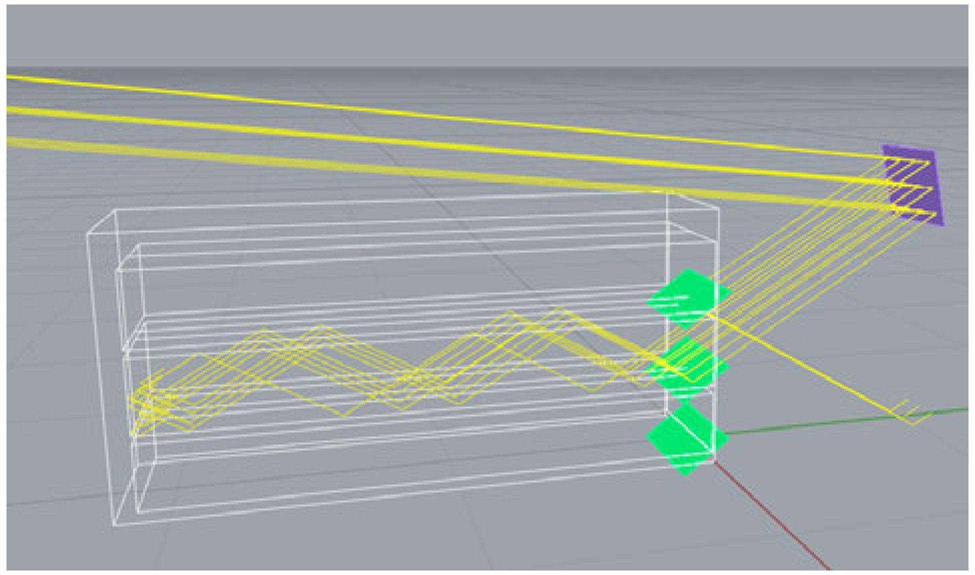
Further developments would look at a broader truss frame for the support arms to minimize shading further and reduce weight and wind resistance.



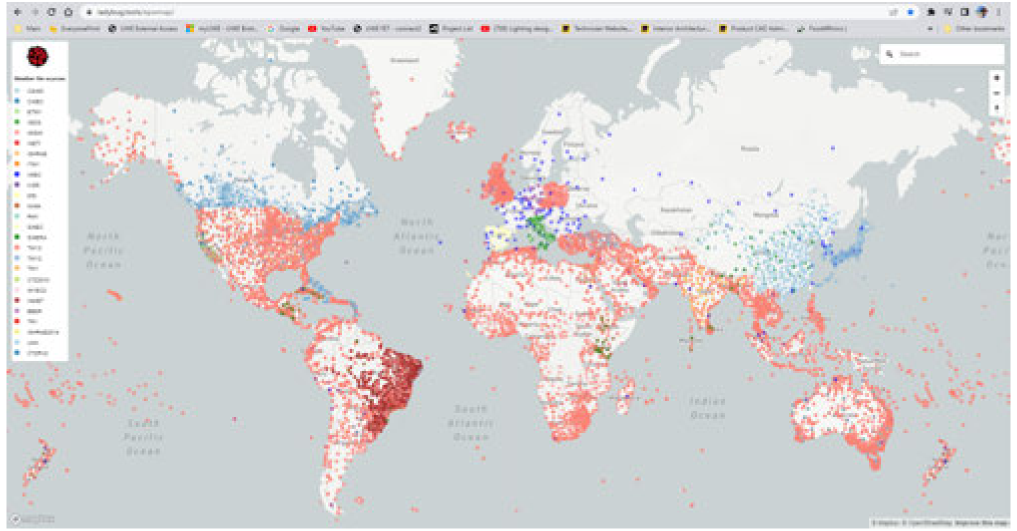

# Testing the Design

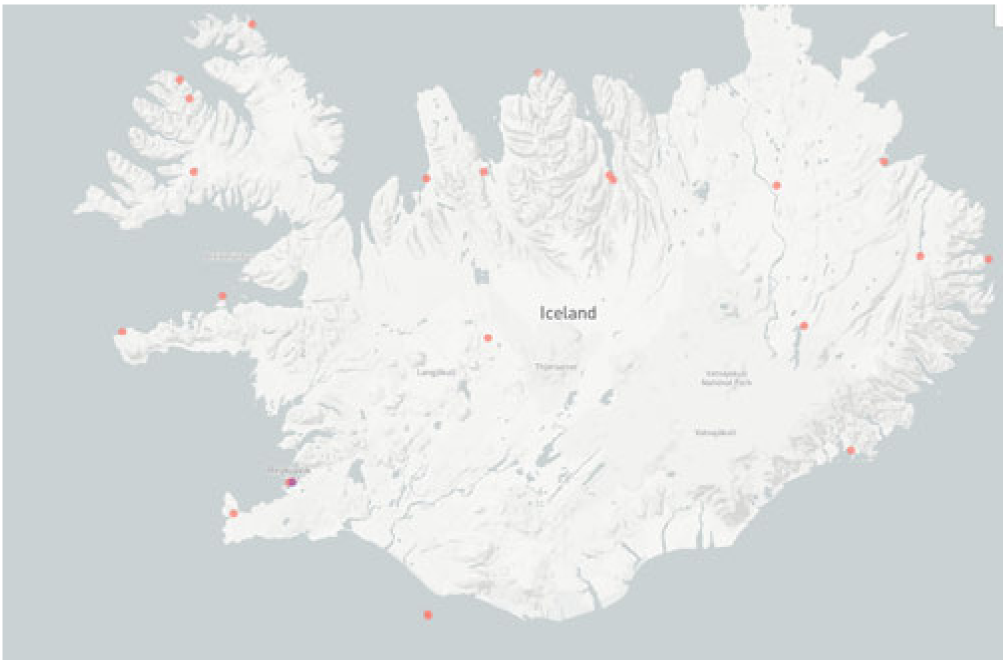
The images below shows a test building (displayed as a wire frame so as to make the insides easier to see) showing how the path of light will bounce off the surface in blue towards the building then bounce again off the second surface shown in green. At this point the size, distance, shape and angles of this components are still to be worked out.





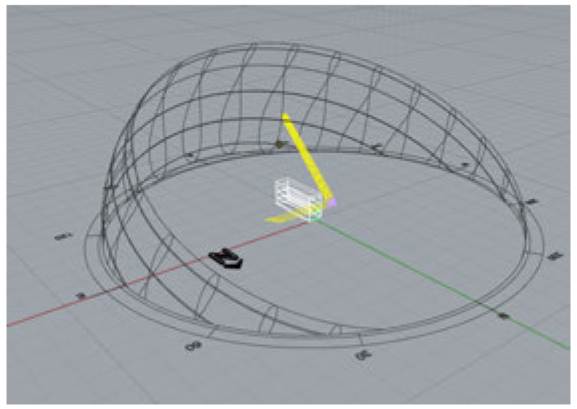
The first step to the design was to look at the location which was situated in the North hemisphere. This project will look at Reykjavik and how to increase the amount of natural light into the north side of builds. Using the website https://www.ladybug.tools/epwmap/ real data from the location can be extracted and take into grasshopper. This data includes lots of different information base on this location such as weather, however the main information this study will be looking at will be sun parts.

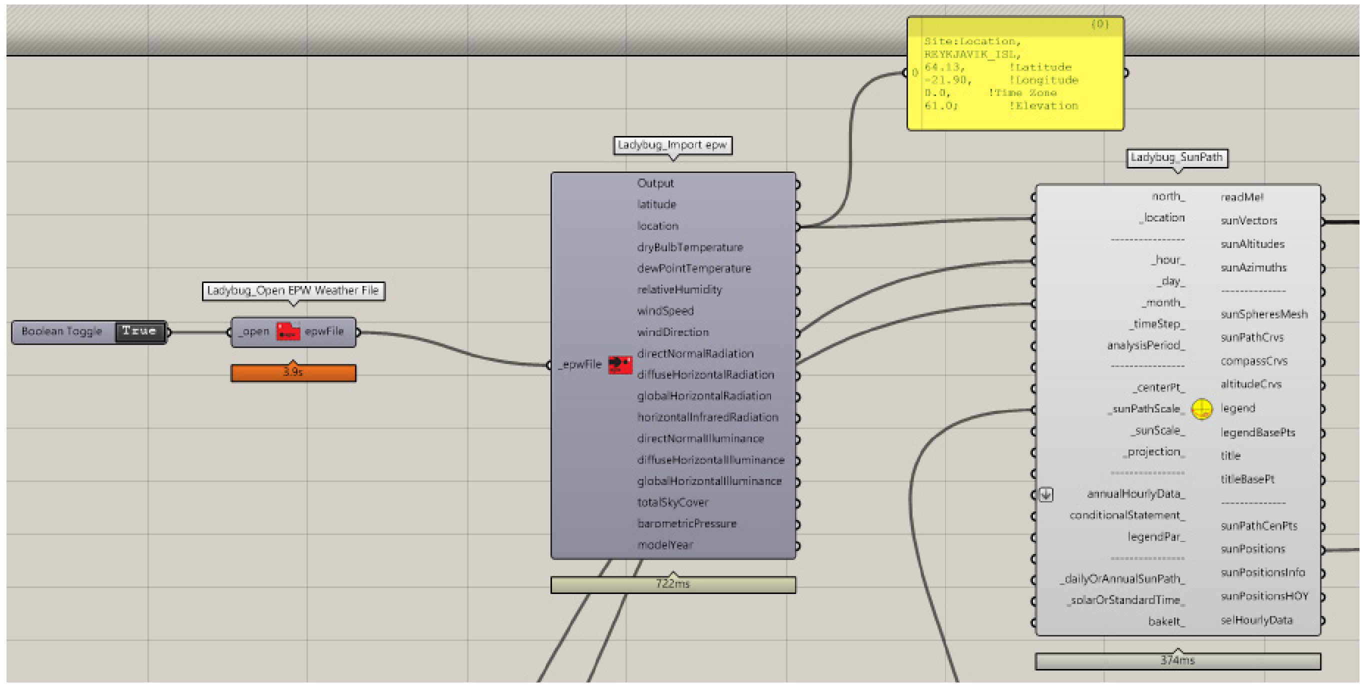




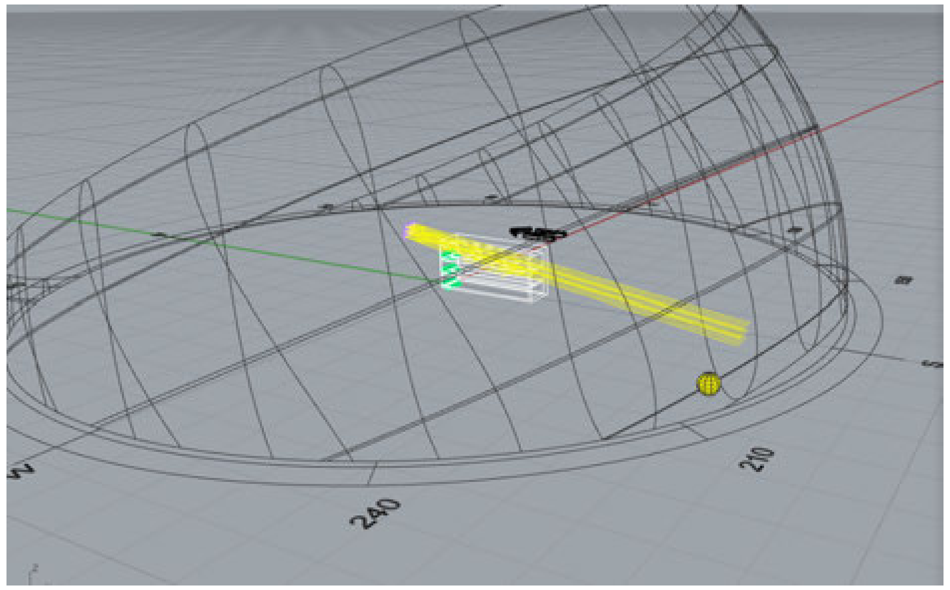

To get the angles of the sun several components (also known as nodes) from a Grasshopper addon called Lady bug and Honeybee will be used in this study. Using these nodes the data can be brought in to the file and influence the design in the simulations.

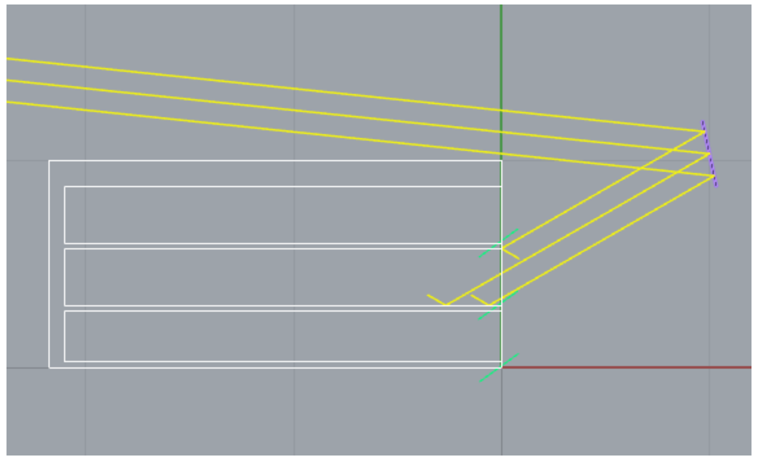
The first nod need was the “Ladybug_Open EPW Weather File” This nod allowed grasshopper to Link to the EPW Weather File downloaded from https://www.ladybug.tools/epwmap/ bringing the data based on the Chosen location of Reykjavik to the simulation. Connecting this node to “Ladybug_import epw” gives the option to what data is wanted from the epw file in this study it will only be the Location. The Next node will be the “Ladybug_SunPath” taking the Location from the last node, This will show the sun path in Rhino. Adding a few number sliders to this will allow for control of different times, for this the time of year and time of year well be looked at. This will give an over all range so as to show the different from high summer to the lowest point in Winter. As well as across Morning to evening. This can be seen in the imagis on the next page.

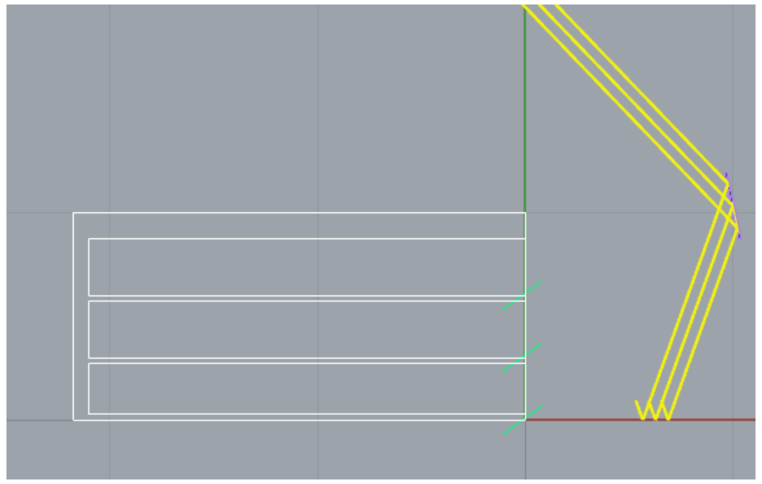


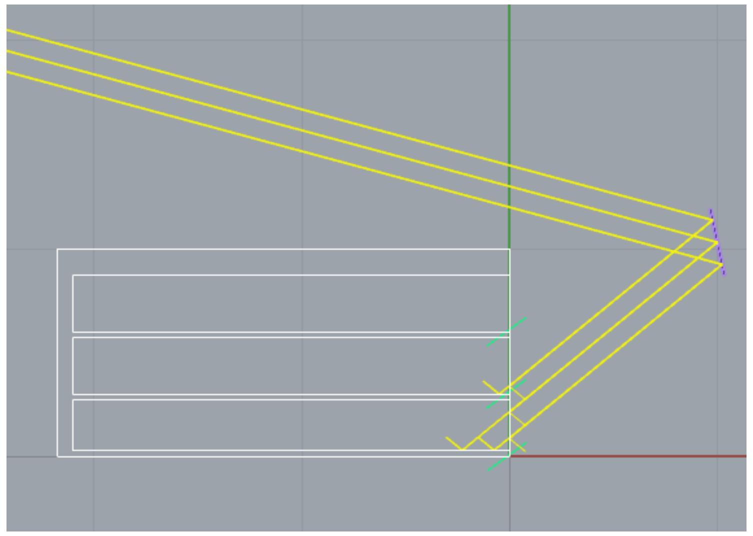


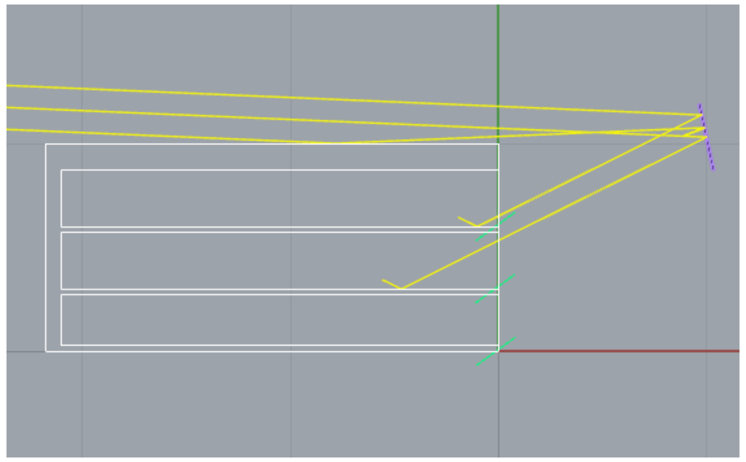
The images on the right hand side of this page show angle the sun rays travel towards the blue panel on the North side of the building at different times of the year. These test times were all done at middle day to show the sun at the highest point of the day. Looking at this information there will be a big different in the angle of the Sun from winter to summer, this will need to be consider when designing the system of reflecting light into the building. It may be possible that the light natural reflected in to the building is sufficient during the summer months if this is the case the system will focus on the winter months when there is less light due to the lower angle of the Sun.

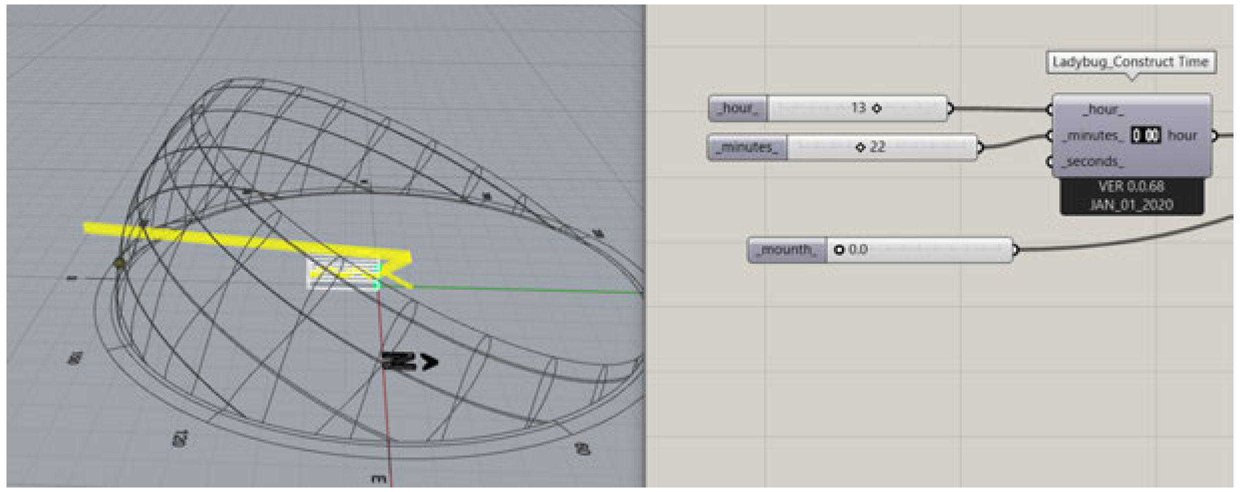


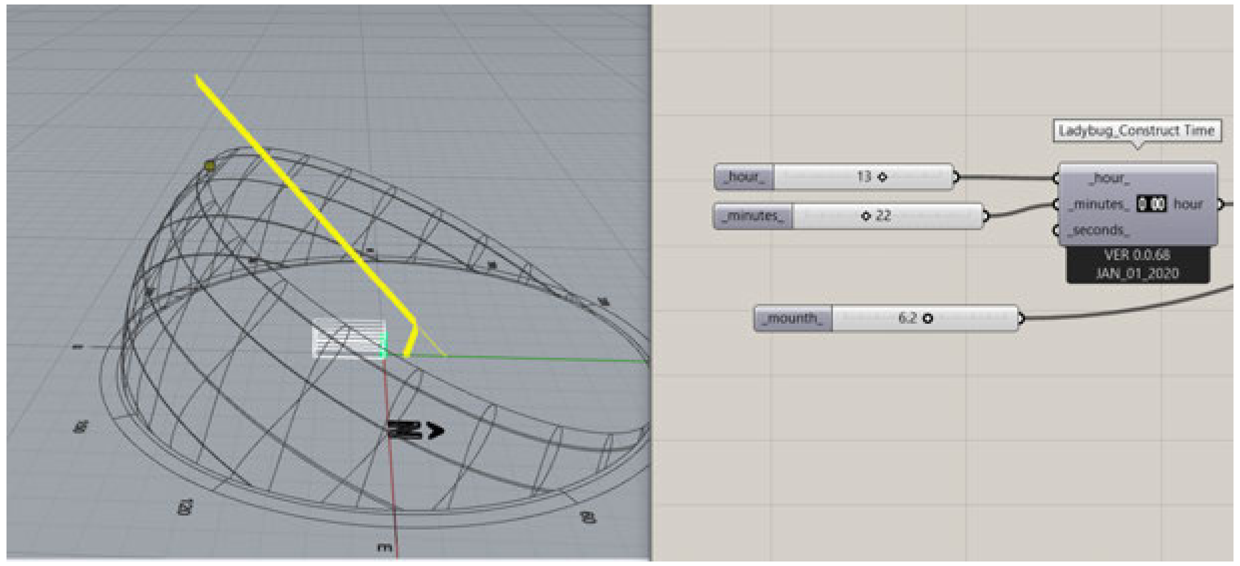



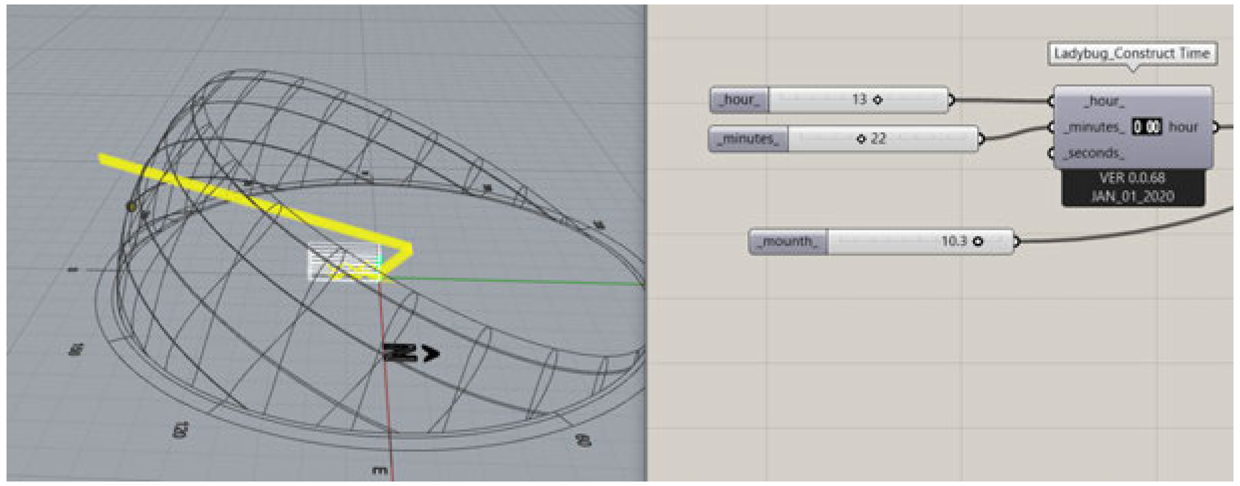


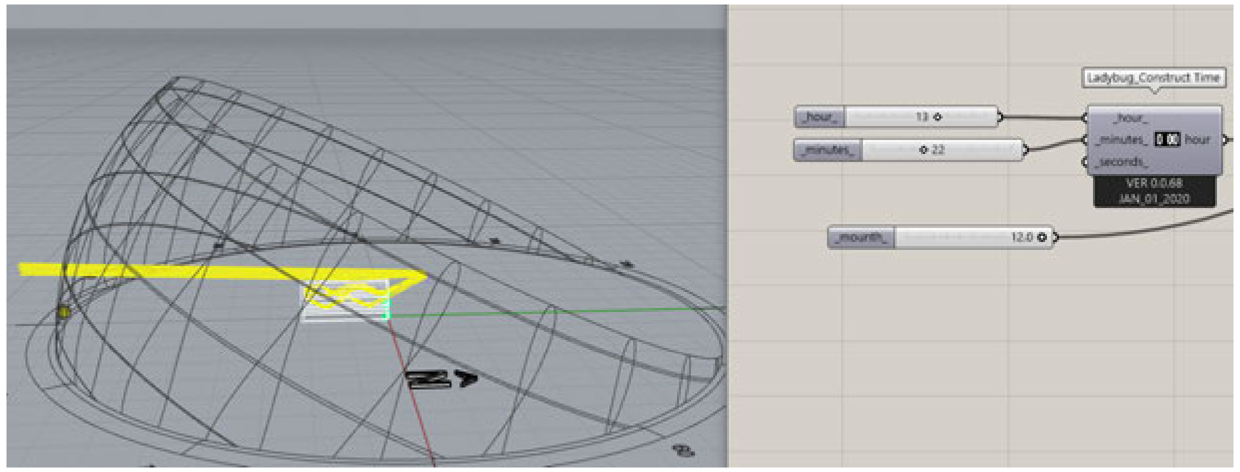




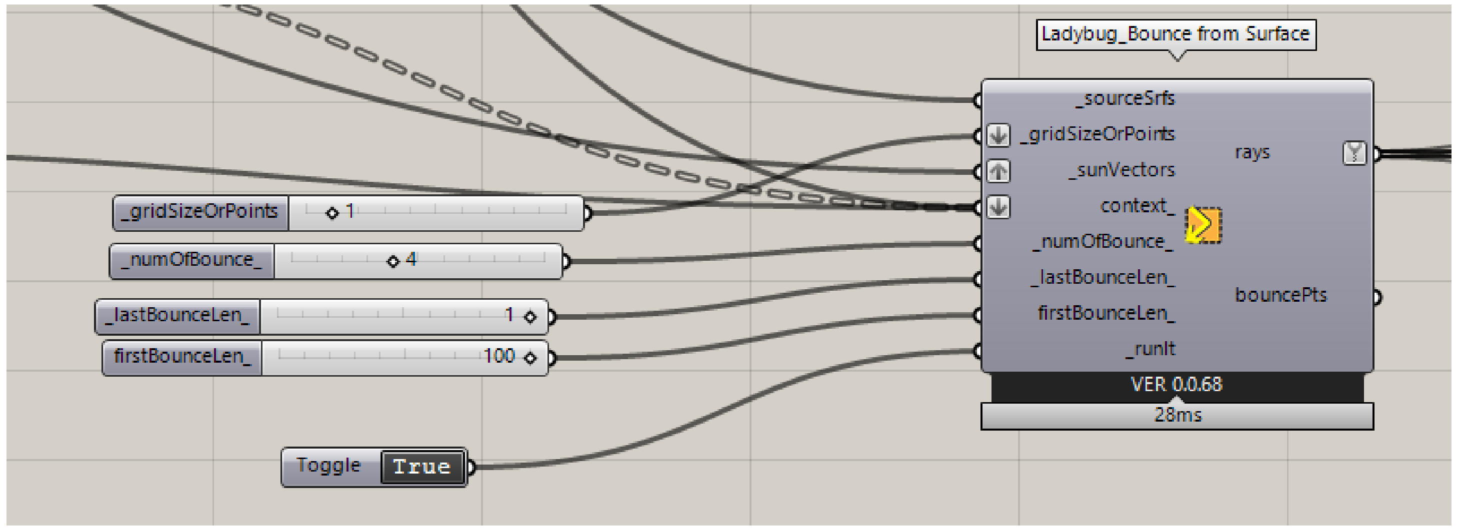


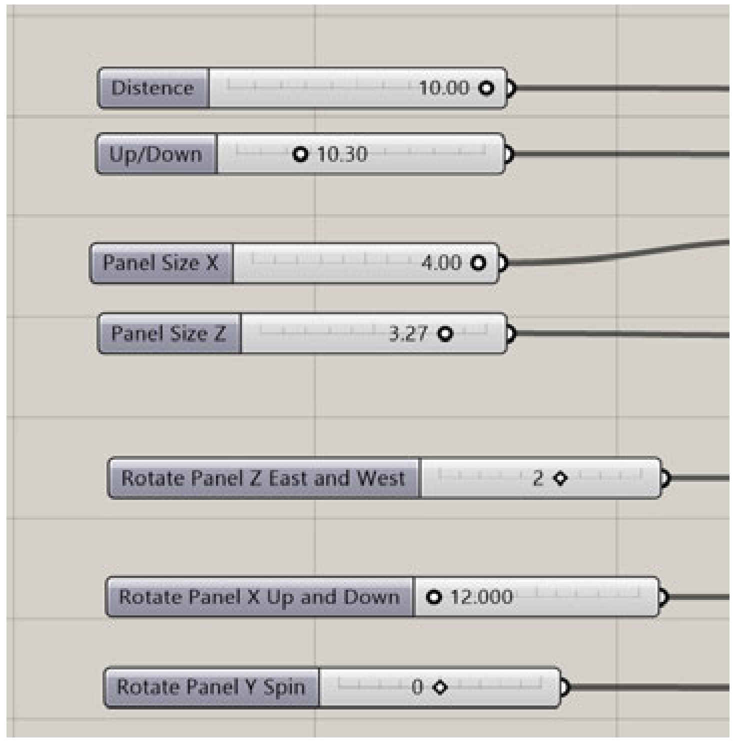



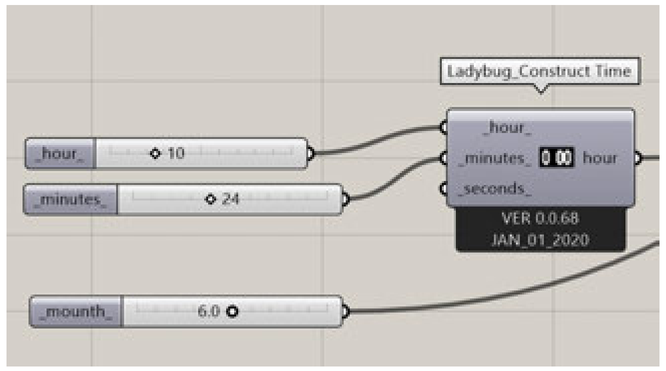



Connecting the "sunVectors" output from the "ladybug_SunPath" Node to the "Ladybug_Bounce from Surface" This gives the bounce effect of the of the light hitting a surface then reflecting. The in puts to the node include "_sourceSrfs" this will have the original shape that the light reflects from in this case the blue shape, this in put will be parametrically controlled. The next import in put will be the "context_" in put which will control all the context of the model for this will include the inside of the building the secondary Panels in Green and the ground level which has been made invisible as it is not important for this demo. The context input will show how light will bounce thought the model. The Input labelled "_numOfBounce_" controlled the about of times to light will bounce. It is import to note that the Light bouncing thought this model is only shown as a Vector for simulation purposes.



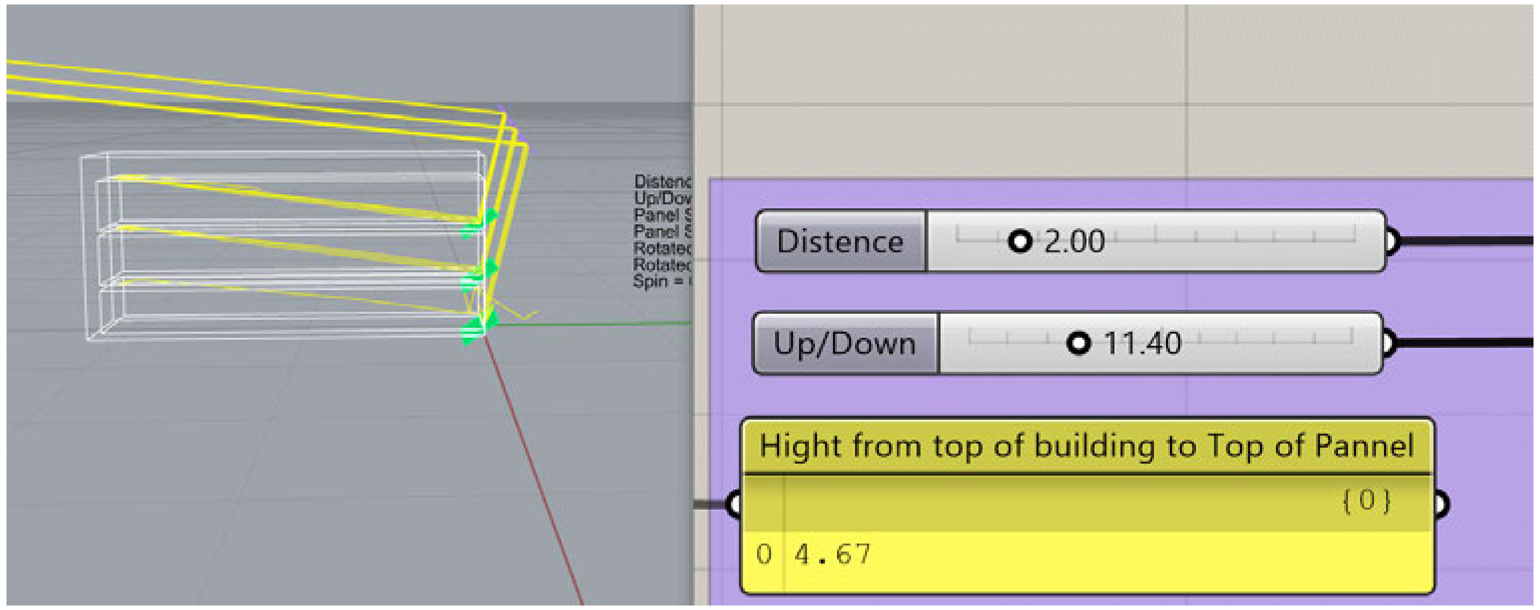

To find the parameters for each of the panels they have been set up with the following controls as can be seen in the imagine to the left. Below are the controls for changing the time of day and time of year these will be use during the testing proses.



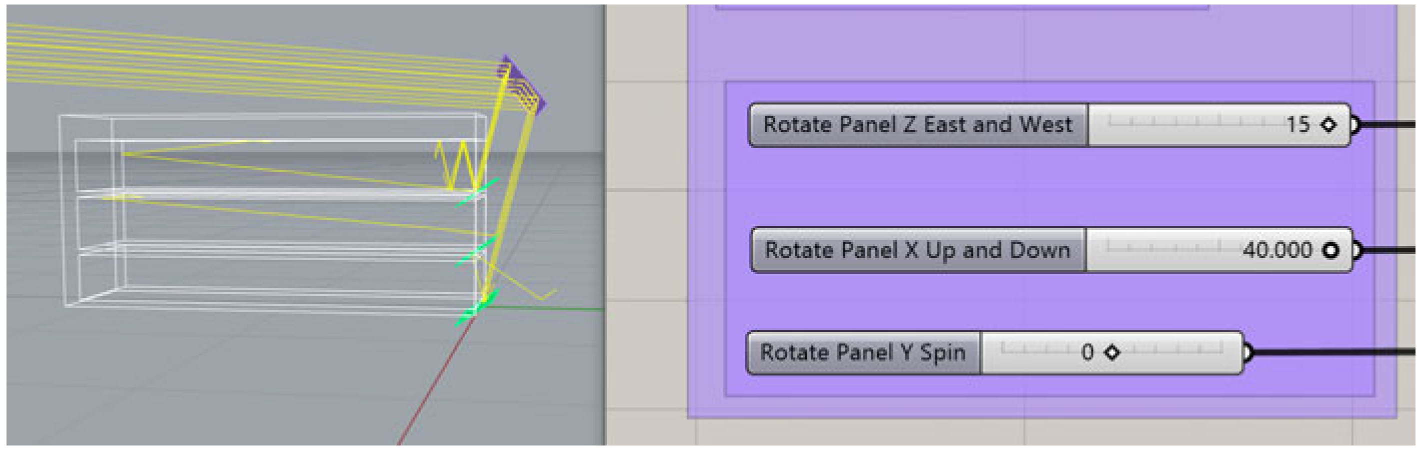

The Distance Parameter will control the distance from the building the panel will be located. By changing the upper and lower limits it will be possible to set a reasonable distance to start with 0 to 5 meters was set as this distance, this can be changed later on, Ideally the lower the amount the better. This test was done around middle day during the winter when the sun is at it lowest point.



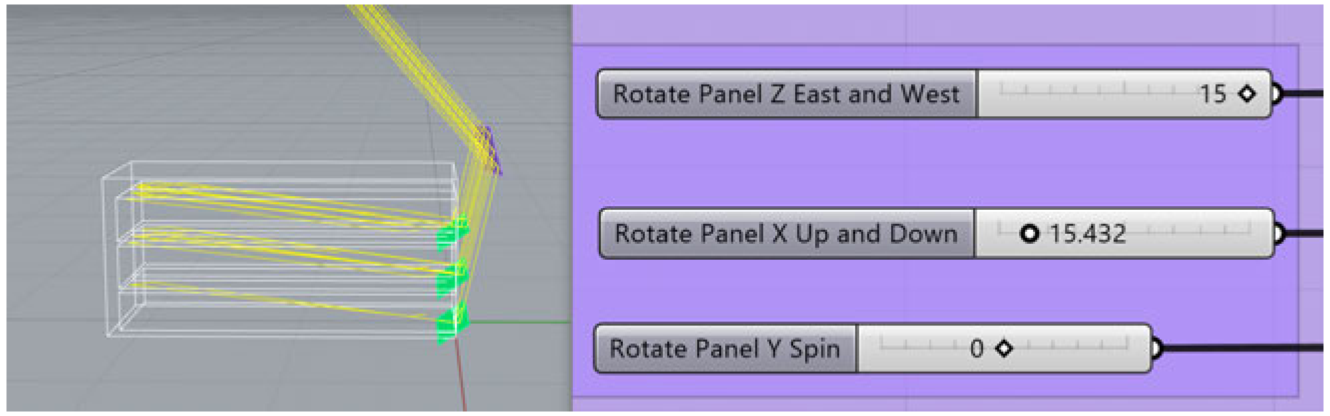



After testing the Distance around Two meters seemed to be the right distance for further testing.

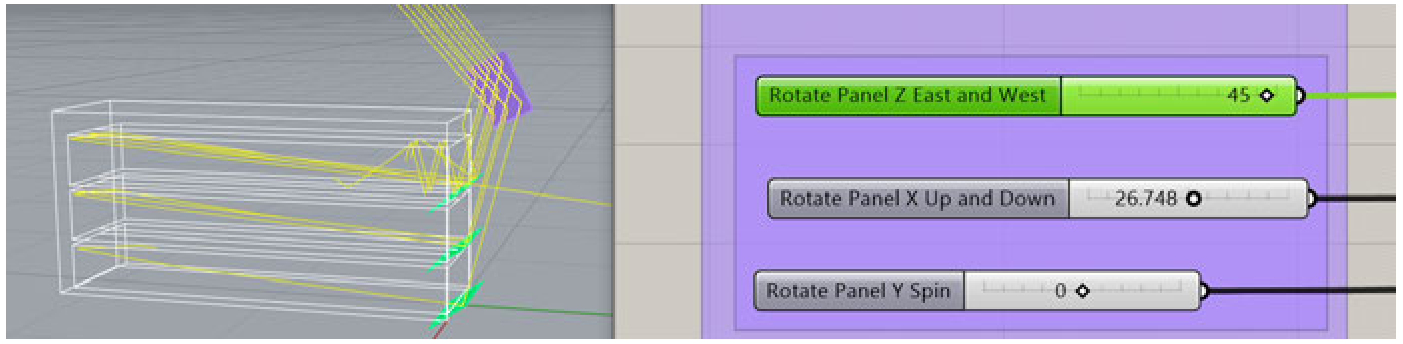
Another Test was done around first light of the same during winter the Distance for the this output was fine however the angle need to be adjusted to a 40 degrees pointing down. After completing several more tests at different times of year this appeared to be the most difficult time of year and as such need the most extreme angle. This will mean on designing this panel the maximum it will have to rotated down will be 40 degrees, as this was when the sun was at it lowest all other angles will be less.



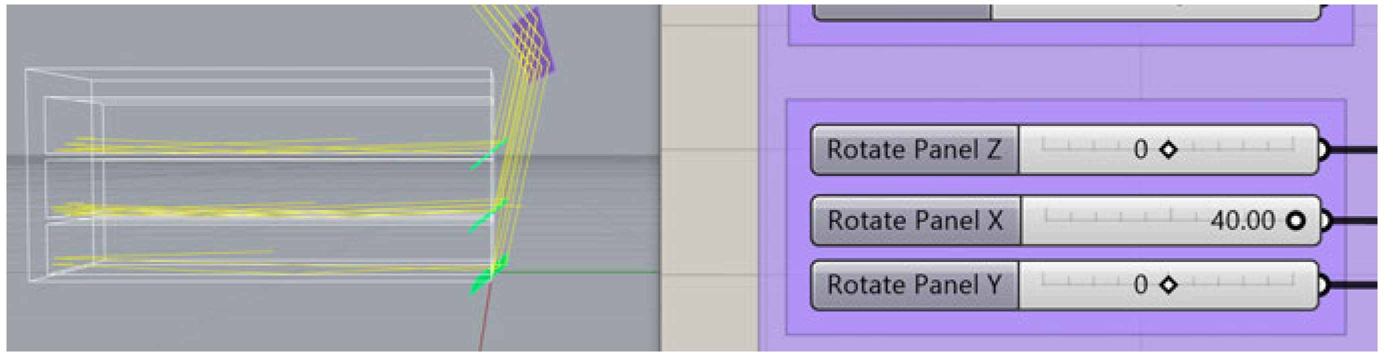

Swapping to Middle of the day in Summer while the sun will be at its highest the angle of rotation will be reduced to the lower limits this appeared to be 15 degrees pointing down. This mean the totally different between the lowest and highest will be 25 degrees this will be the max amount of movement required in the Up and down or X angle, to be safe an extra 10 degrees leeway could be add to final design to allow for unforeseen results.

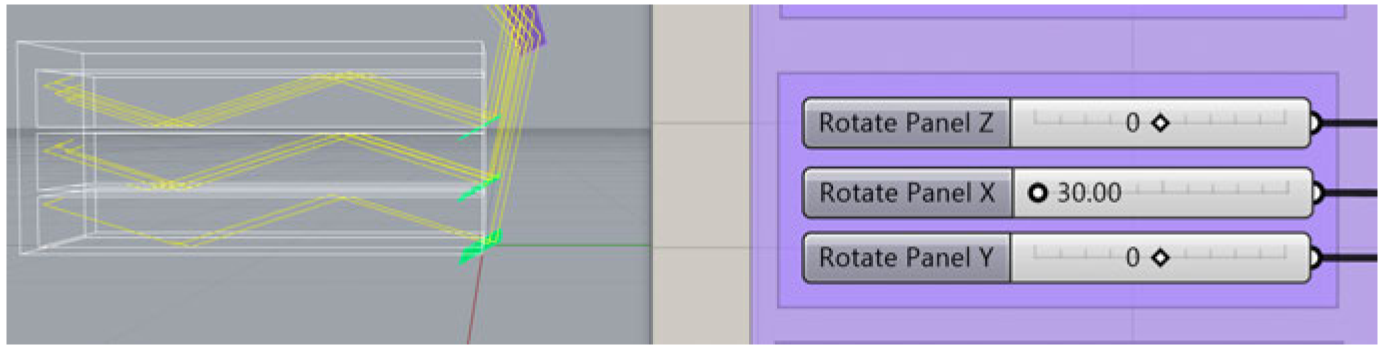


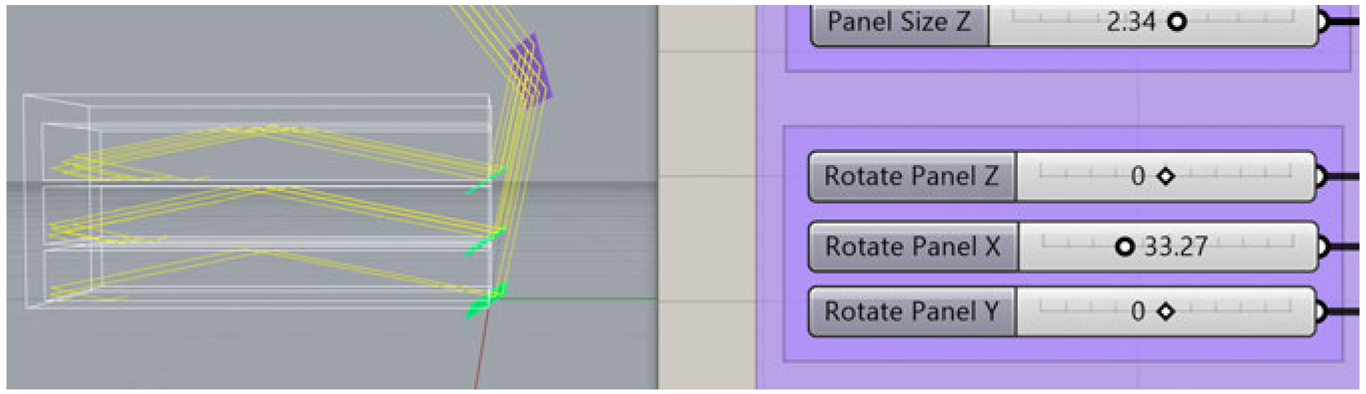

Testing an early time of the day in the Summer the Rotate East and West parameters needed to be increased to allow for the longer summer days, this would allow for 45 degrees to East and West with a totally different of 90 Degrees. Also during the test, the first two hours of sun light did not reach the ground floor due to the difficult of the angle. This could possible be fixed by moving the panel futter away from the building, however as this was only for 2 hours in the hight of summer this is unlikely to be a problem and designing the Panel to be father away from the building could cause more problems.




In the Images below the smaller panels in green were tested to see what angles would work for them. The only angle that would need to be changed for this panels would be the X angle (up/down). The tested showed that theses would only need to rote a small amount about 10 degrees max. With and angle of between 30 to 40 degrees the light could be reflected into the building.



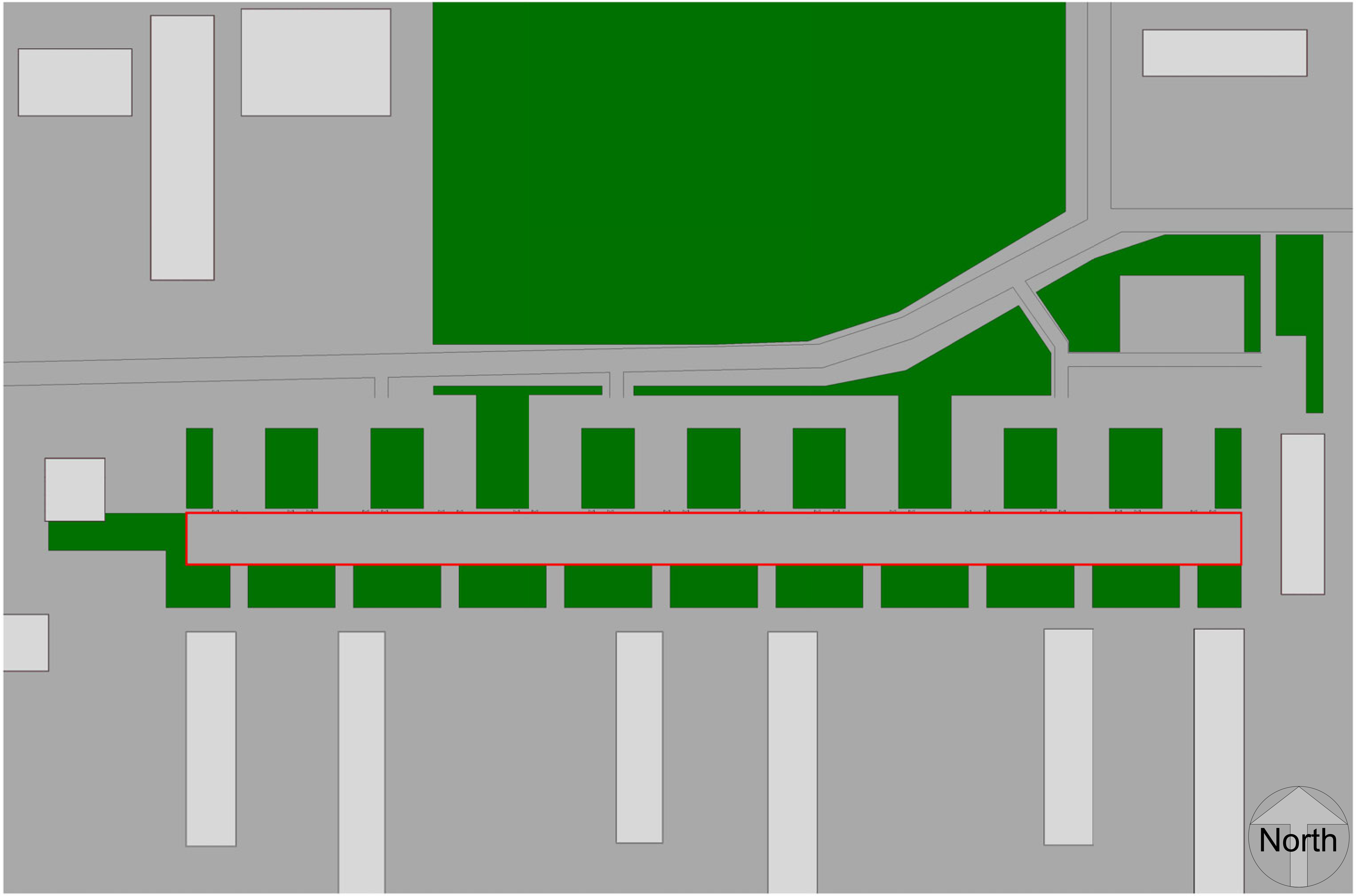
# Location


For the location a building was found in Reykjavik, Iceland. While looking for a site it seemed that most building were built at an angle so as not to have a side pointing directly north. The building that fitted the criteria of having a side of the building the point true north and would befit from having more light to that side. This building is very long going from East to West, making the two main sides of the building on the North and South, because of this the building has larger windows on the South side and smaller windows on the North side.

This building appears to be an apartment building, its long shape is mostly likely so as to maximins light from the south and reduce heat lose by having lots of dwelling next to each other rather than separated building.


North

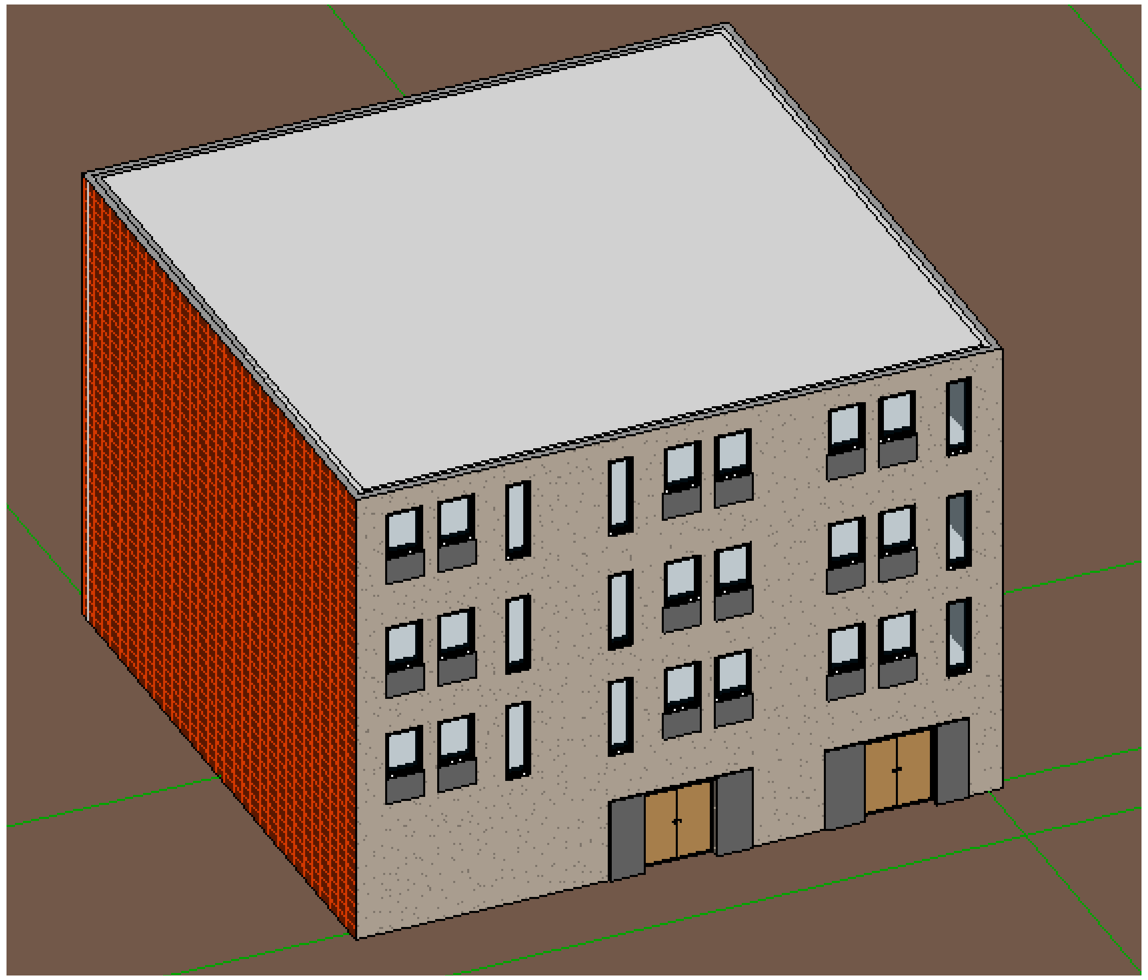
South

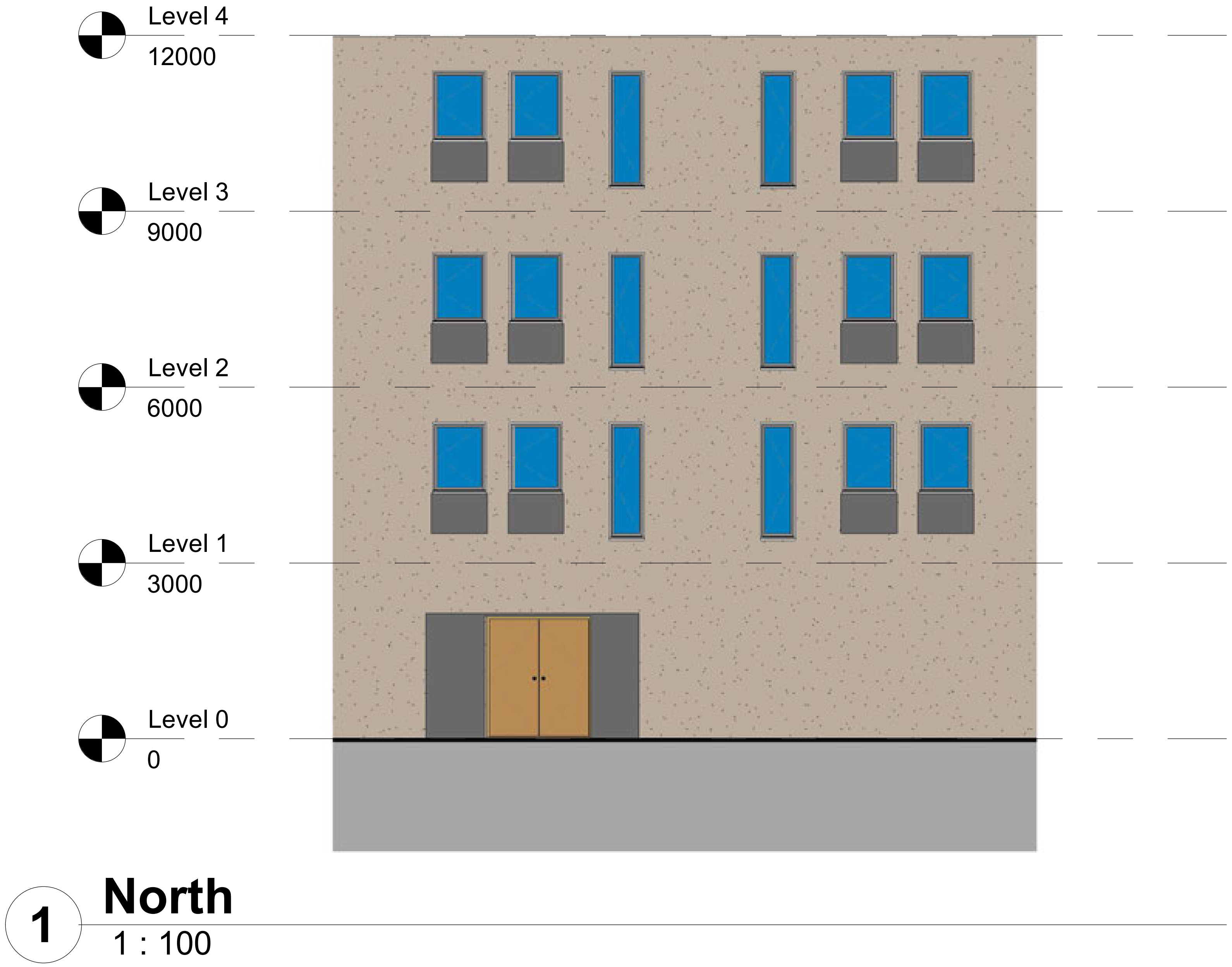



**Site**
1 : 1000

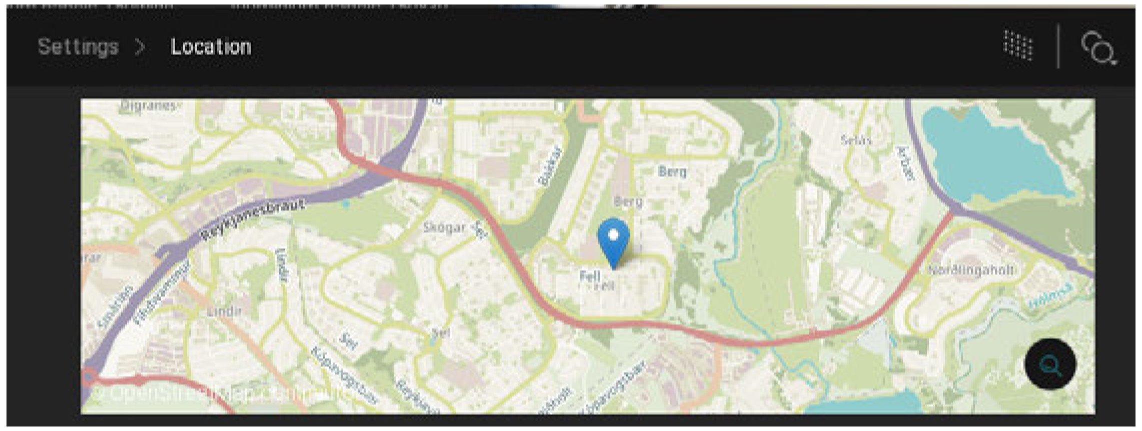
# Revit Test Model

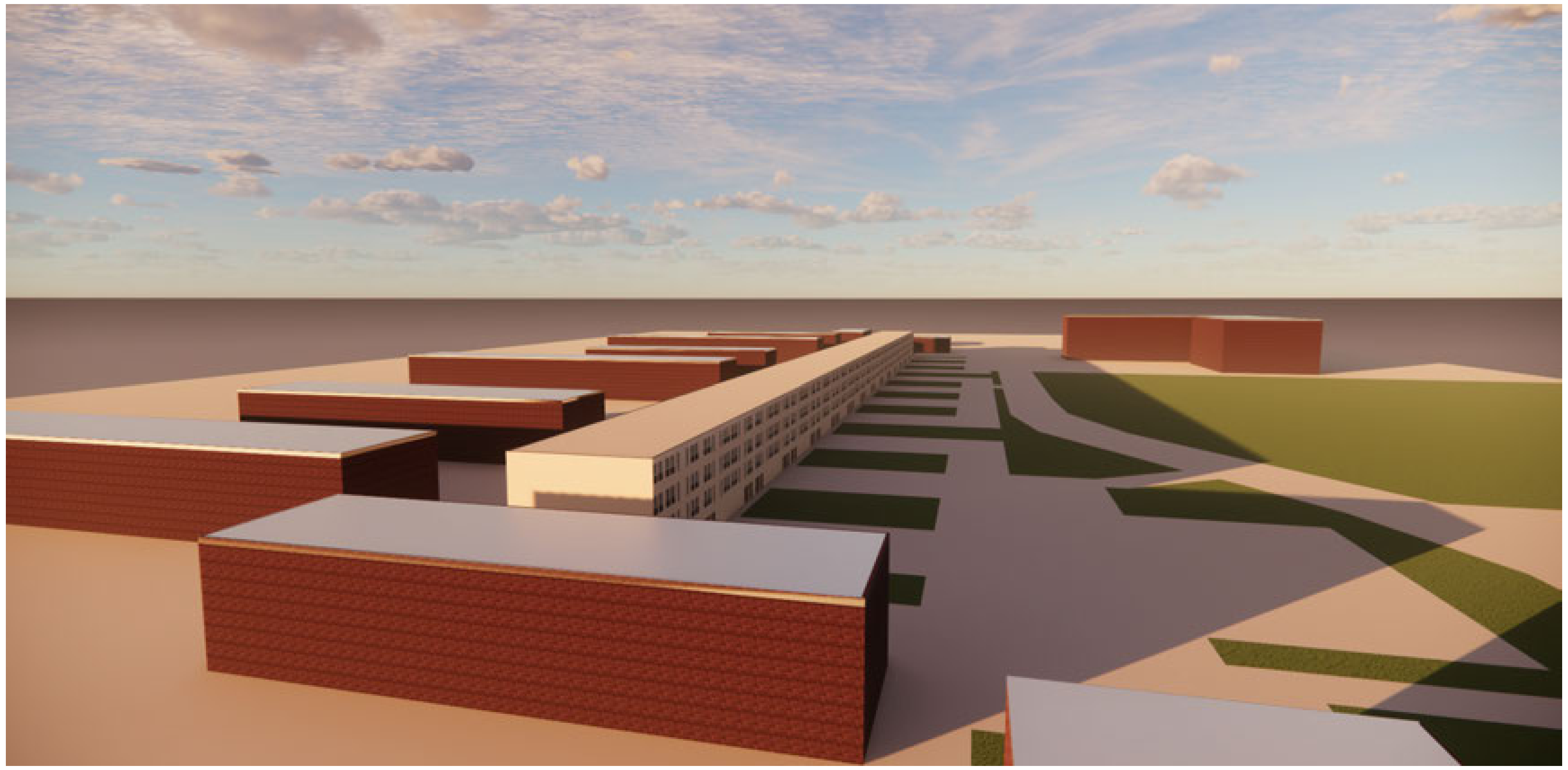
The form of this building is a basic shape that is repeated, this means for testing purposes a simplified version looking a part of the building. As this study will be looking at the North side only the rest of the model will no be modelled ie the Windows on the South side.

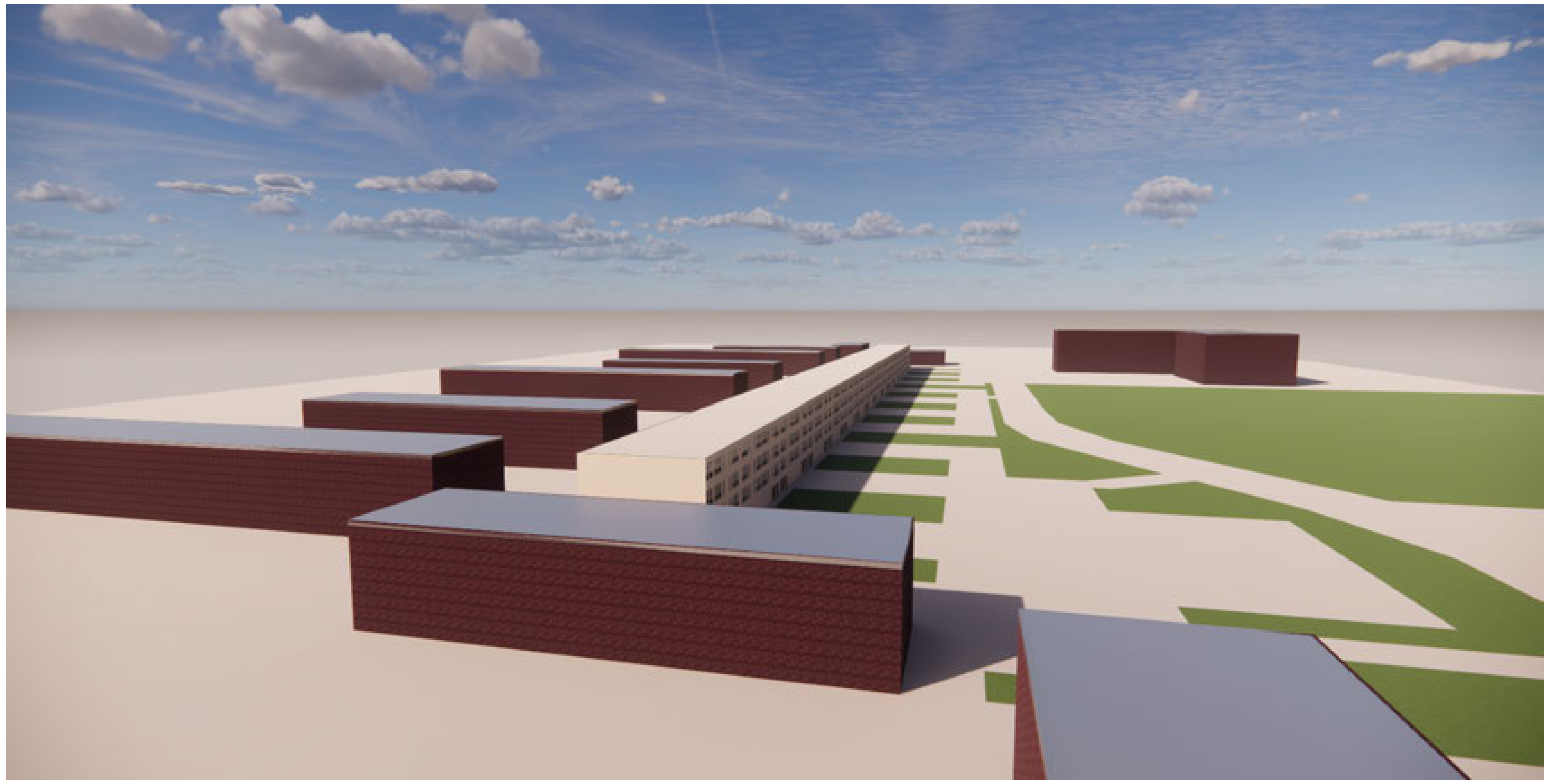


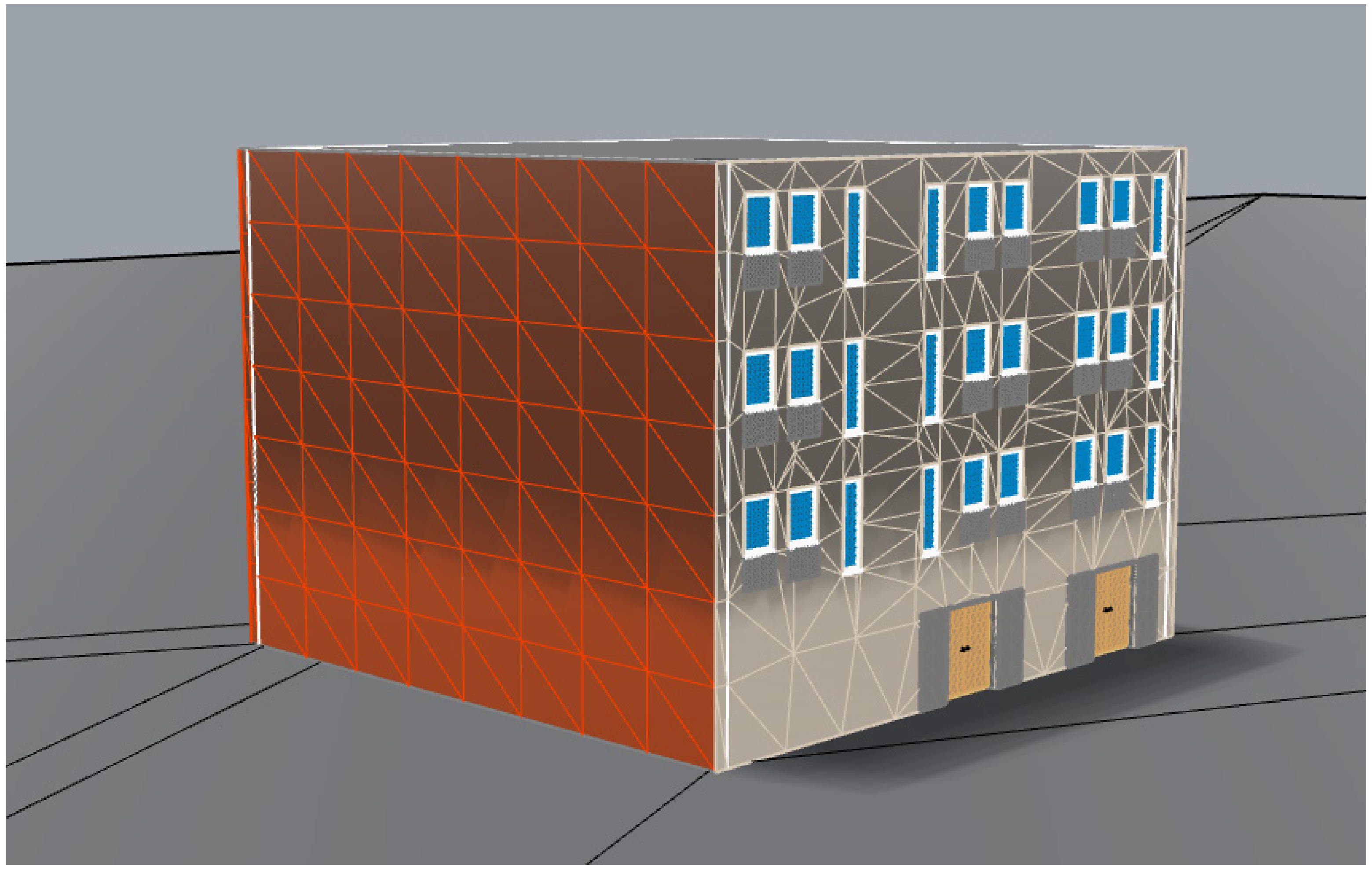


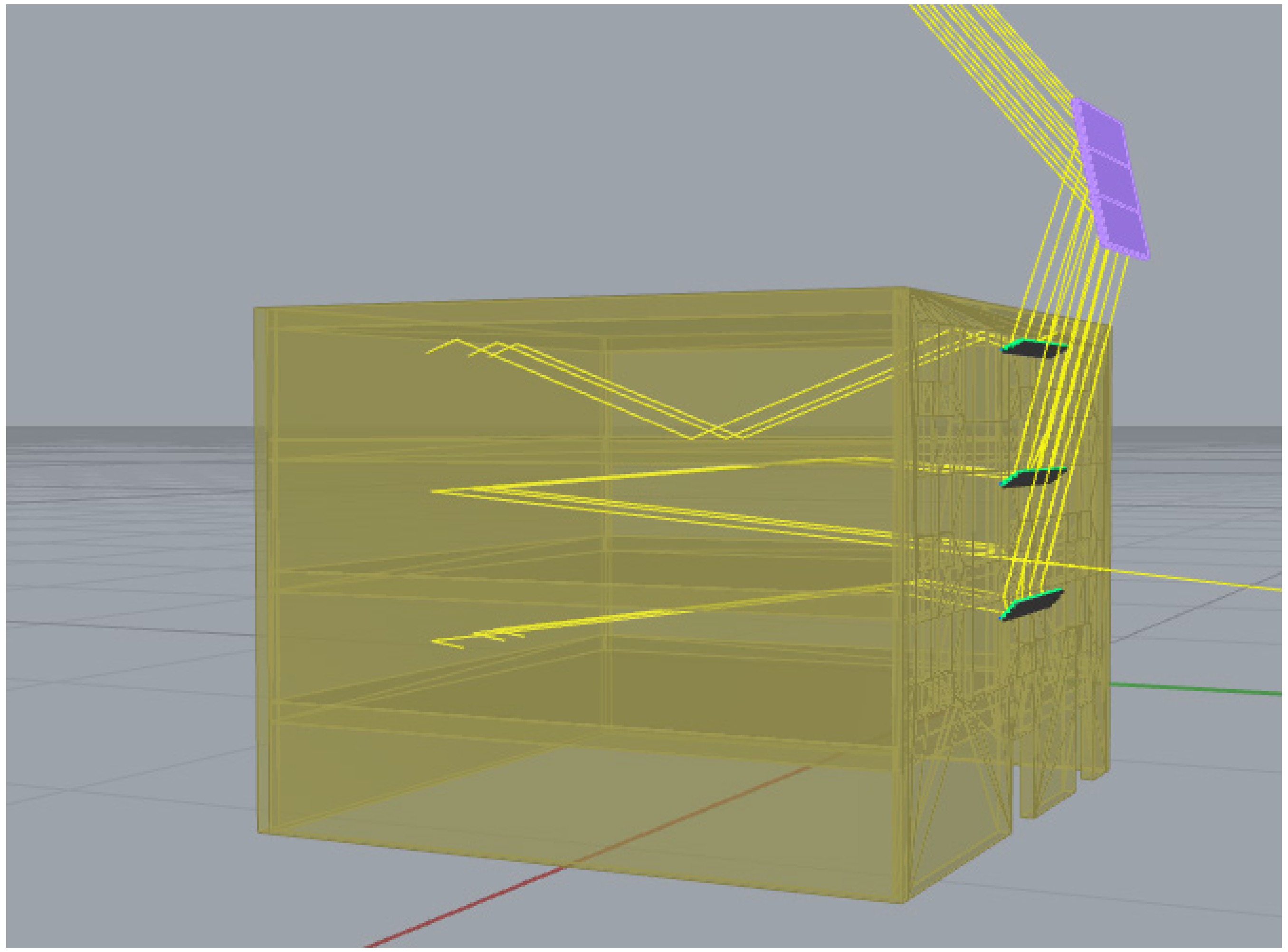

Bringing the Full Revit model in to Twinmotion will allow the model to be tested in different times of the year in the correct location as seen in the images on this page. This combined with the testing done in Grasshopper will help generate the design for this projected.



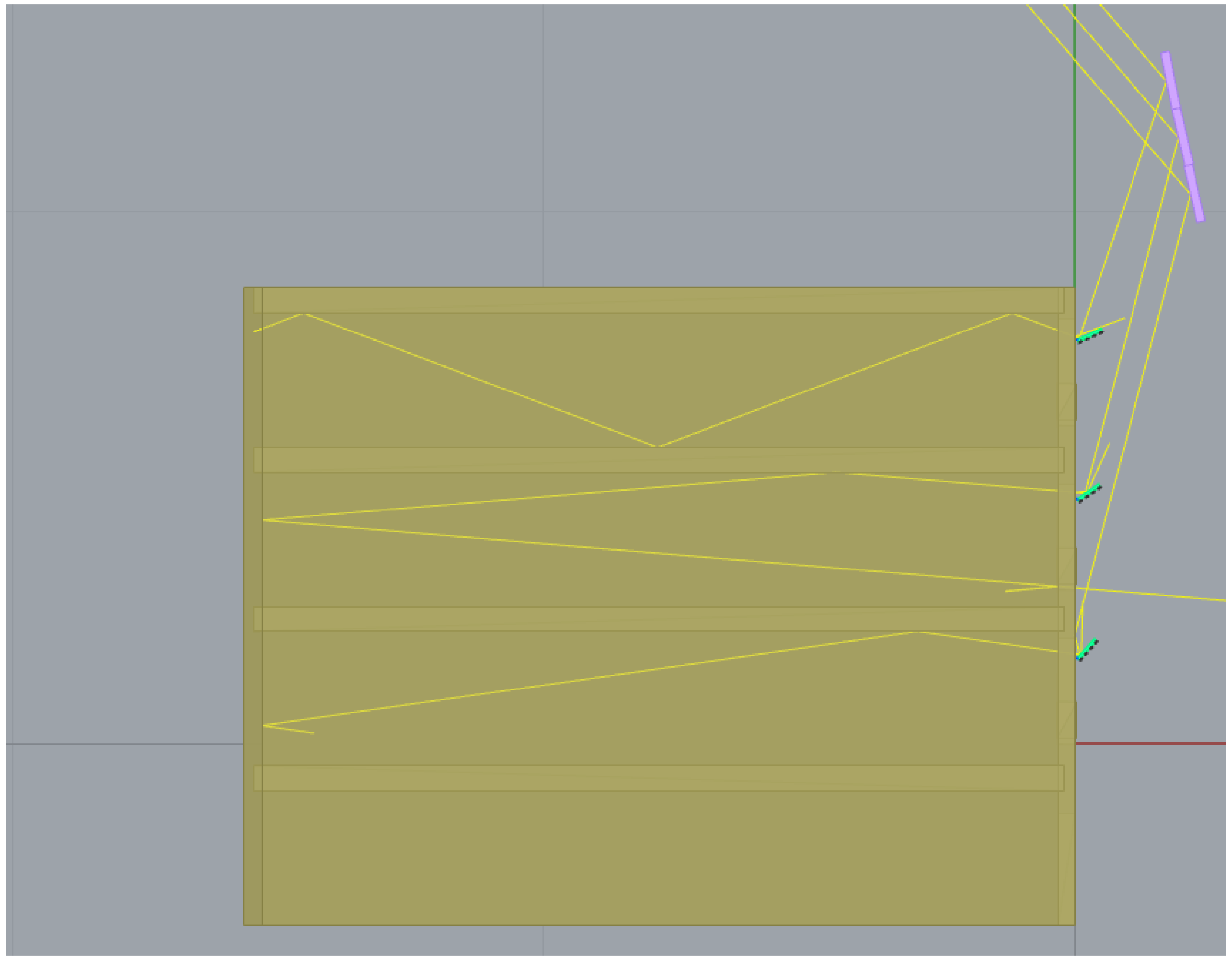


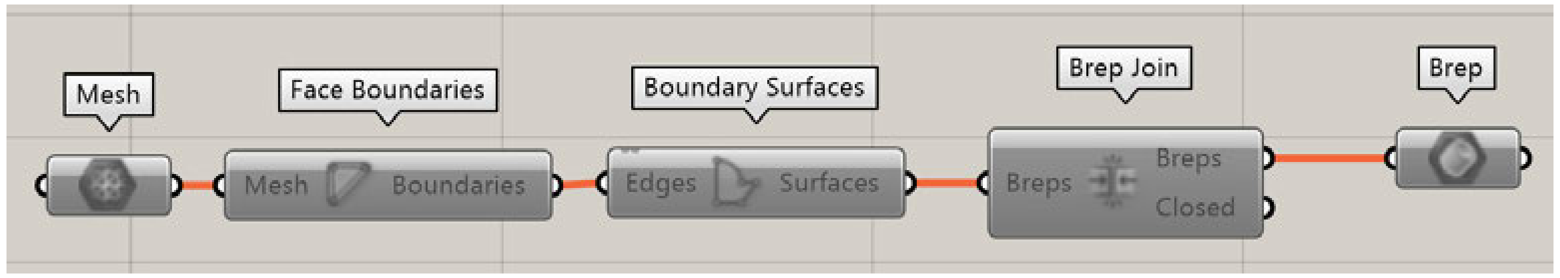


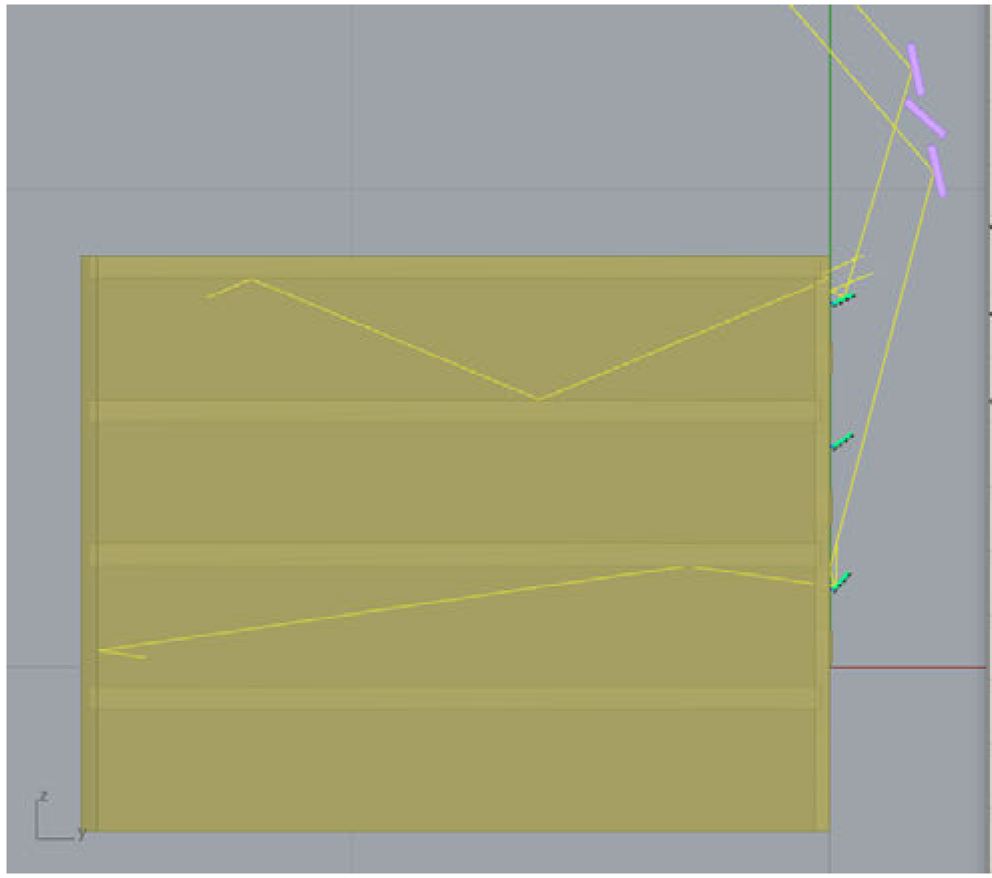


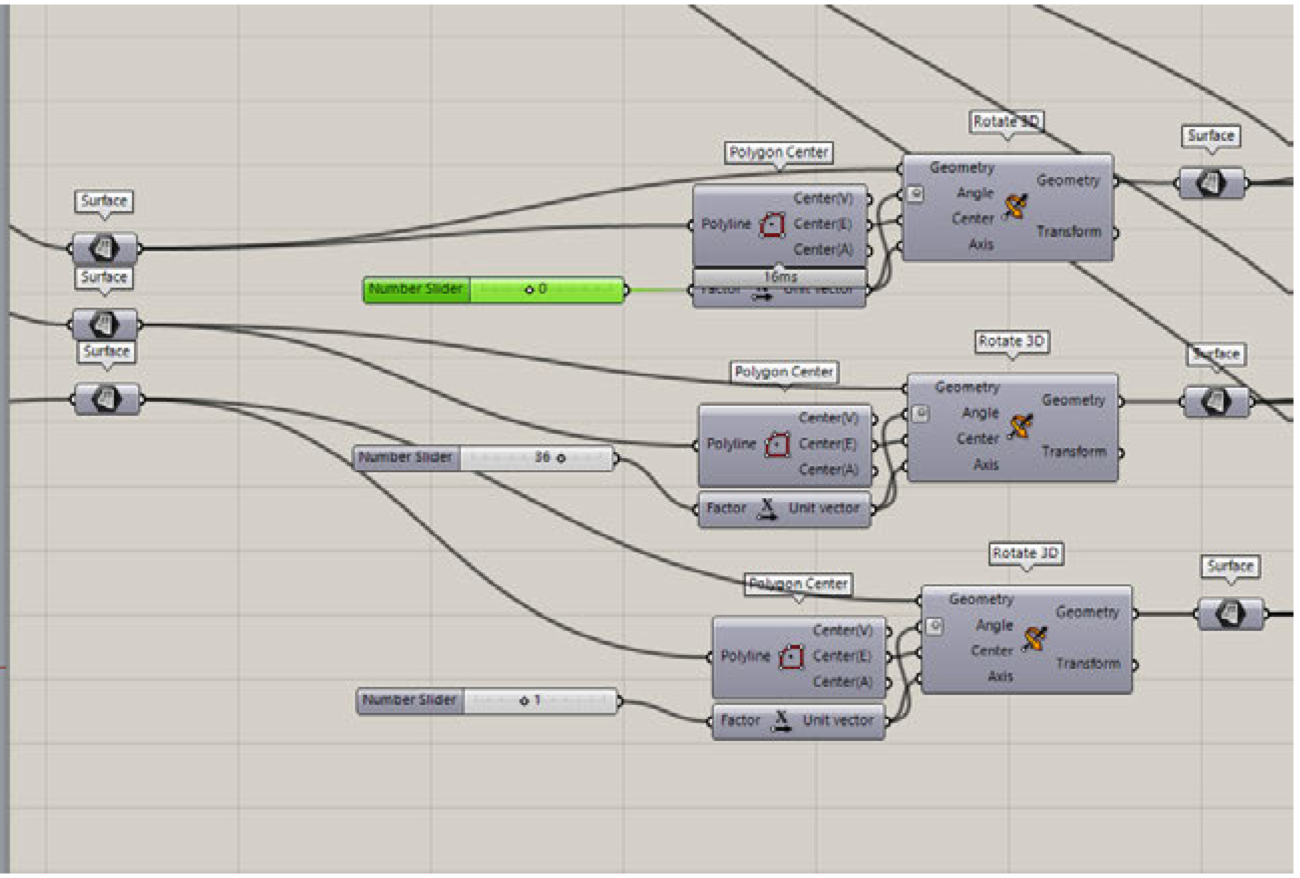
The next step was to bring the Revit Model into Rhino. Once in Rhino any element that where not needed for testing such as the window and doors were removed. Once this was done the remaining parts were joined together in a closed mesh, this ended up being a large file to work with as the mesh face count was far too large so a "ReduceMesh" Command was used to decreases the polygon mesh face count. Then bring that into grasshopper using the Mesh node will allow for more testing  by converting it to a Brep so as to be able to test the Bounce from Surface node.

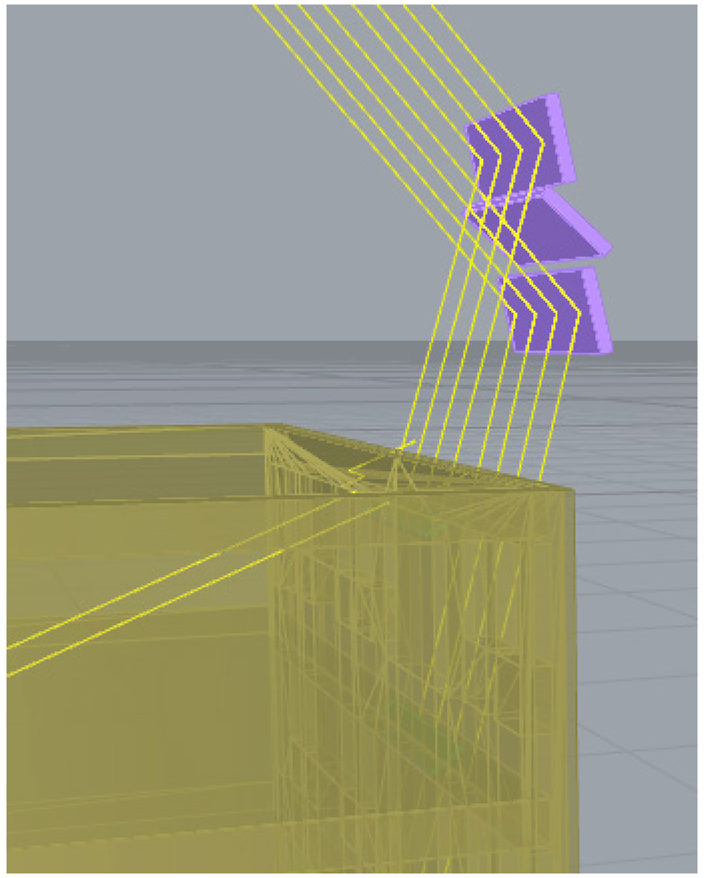
This Building doesn't appear to have any windows on the ground floor on the North side. Because of these the Design will focuses on the 1st, 2nd and 3rd floors.





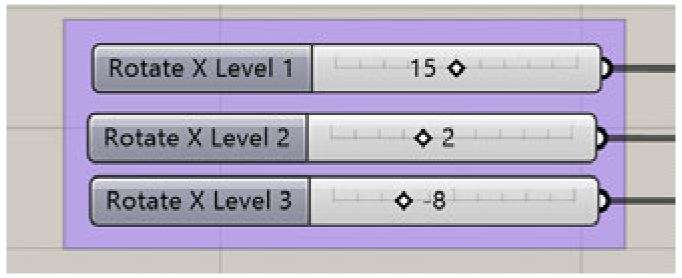


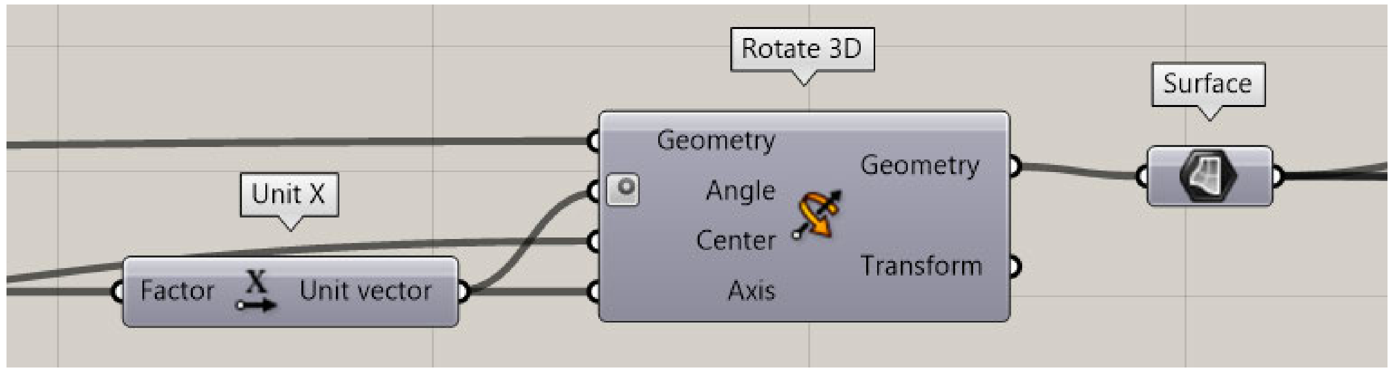


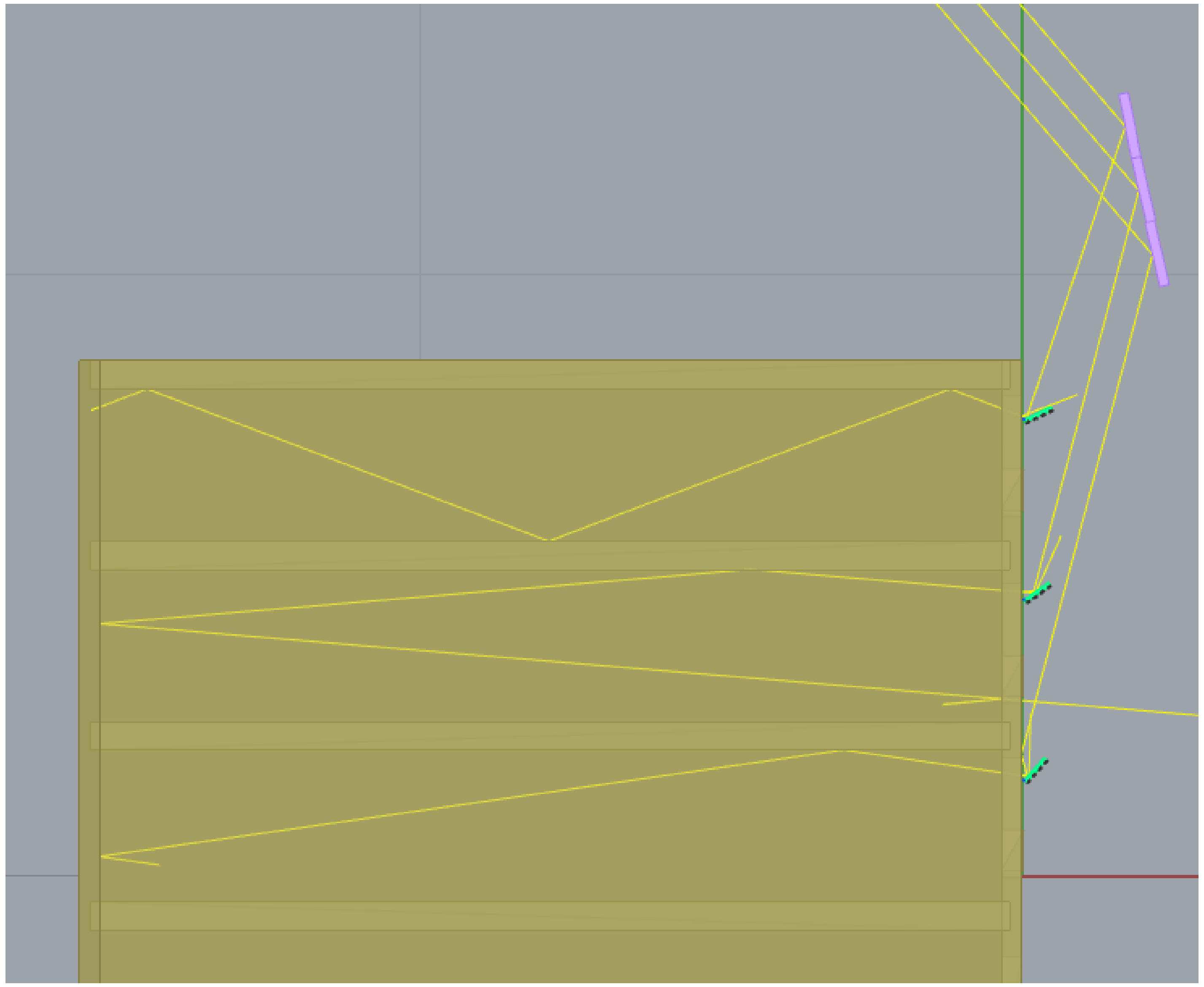



This part of the experiment looked at different options for the panels. It was assumed that splitting the top panel in to three one for each lower panel would help the angle of reflection. However this didn't appear to help as each of the panel required the same angle as each other, even when tested at different times of year. This will mean that a single Panel will be the best and simplest Design option for the main reflecting Panel.   This can be seen in the Images above.

However during the testing of the Lower Panels it was found that different angles for each floor would be required to get the ideal angle for each level. This can be seen in the Images below and to the right.

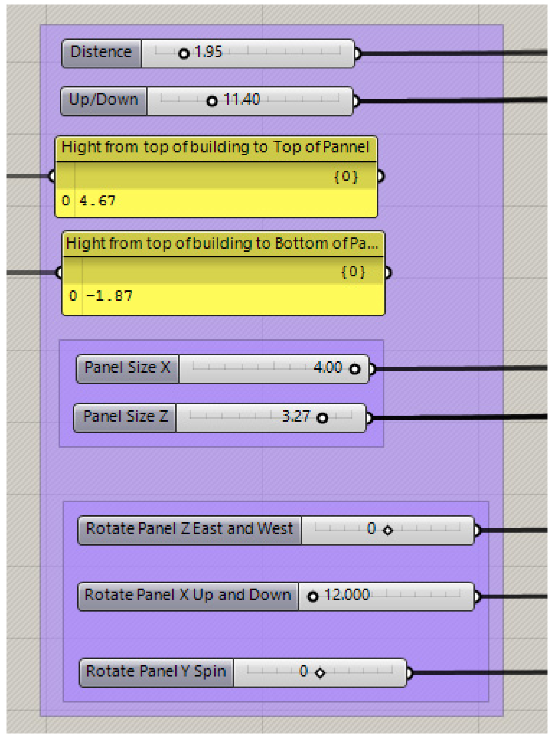


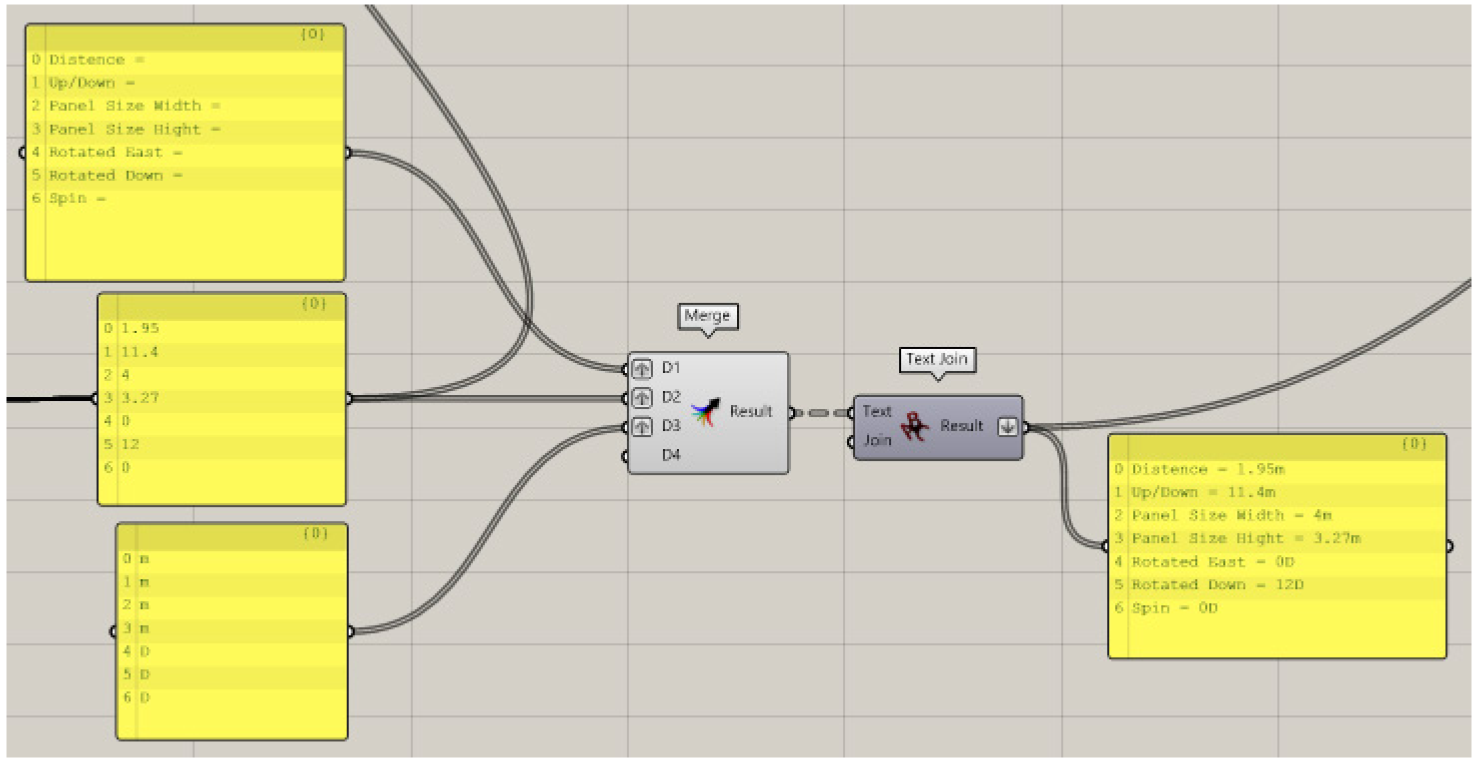



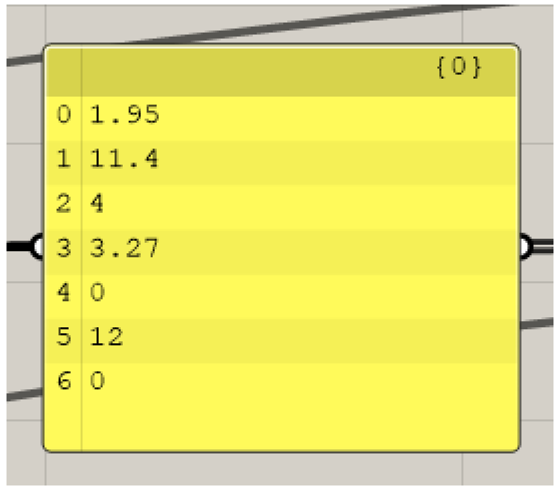



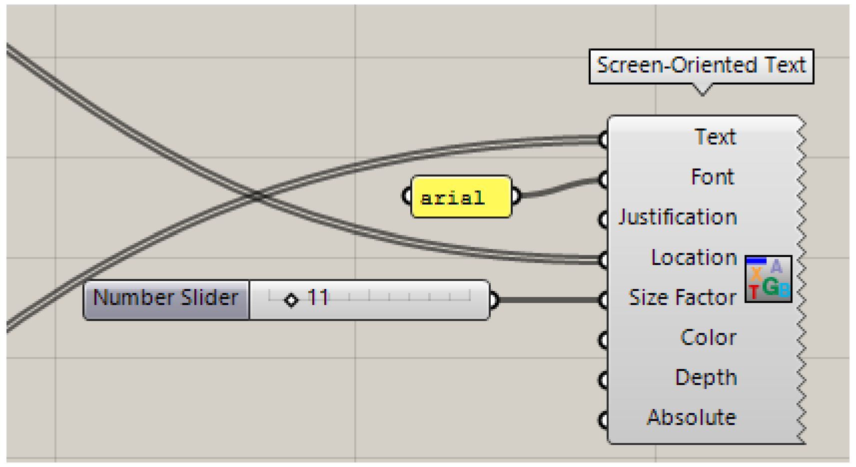
# Adding Labels to Data

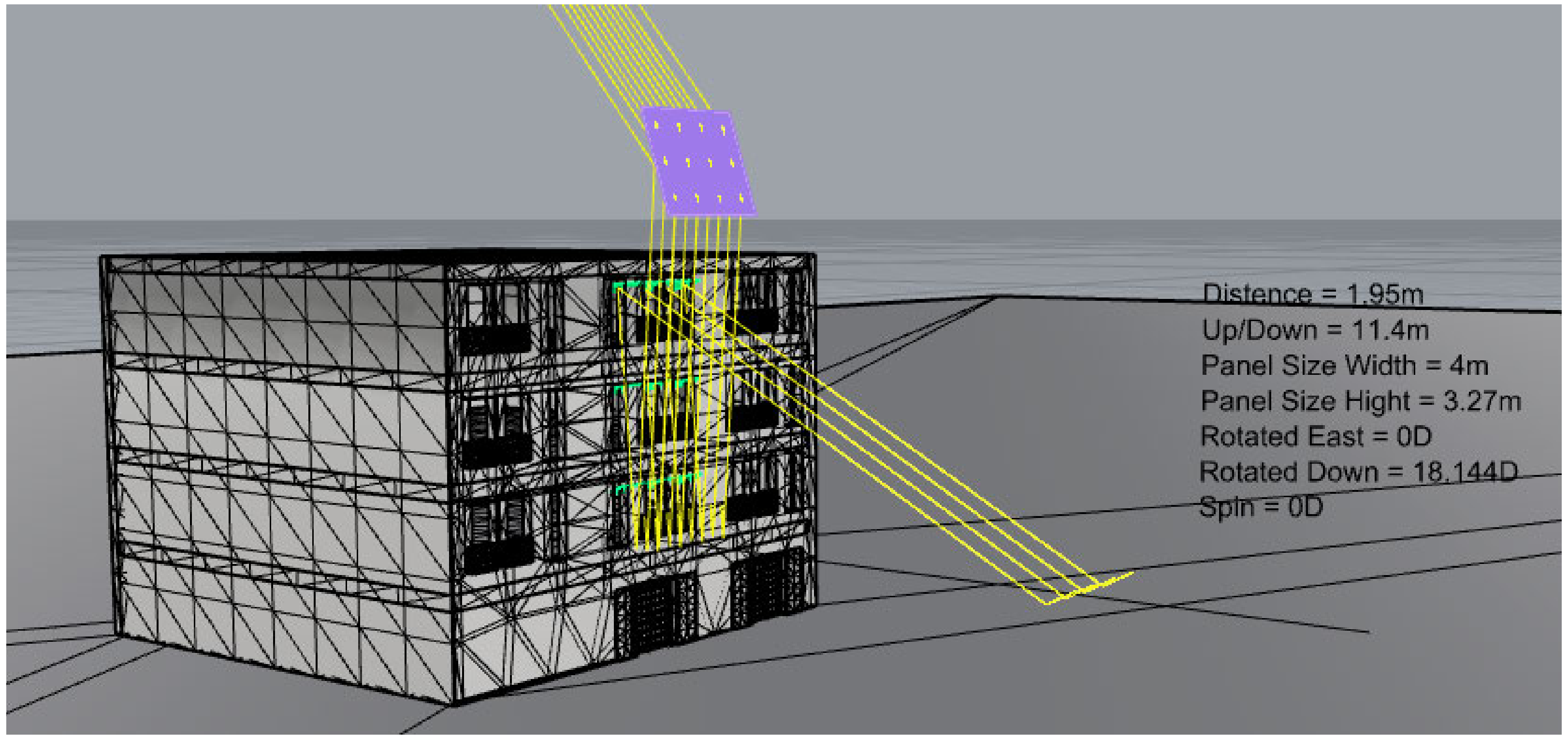
By taking the input slider data and putting that into a panel then merging that data with a list of the labels for each parameter a combined list can be created to easy display the information regarding the panels this can also be displayed on the screen in Rhino using a “Screen-Oriented Text” node.

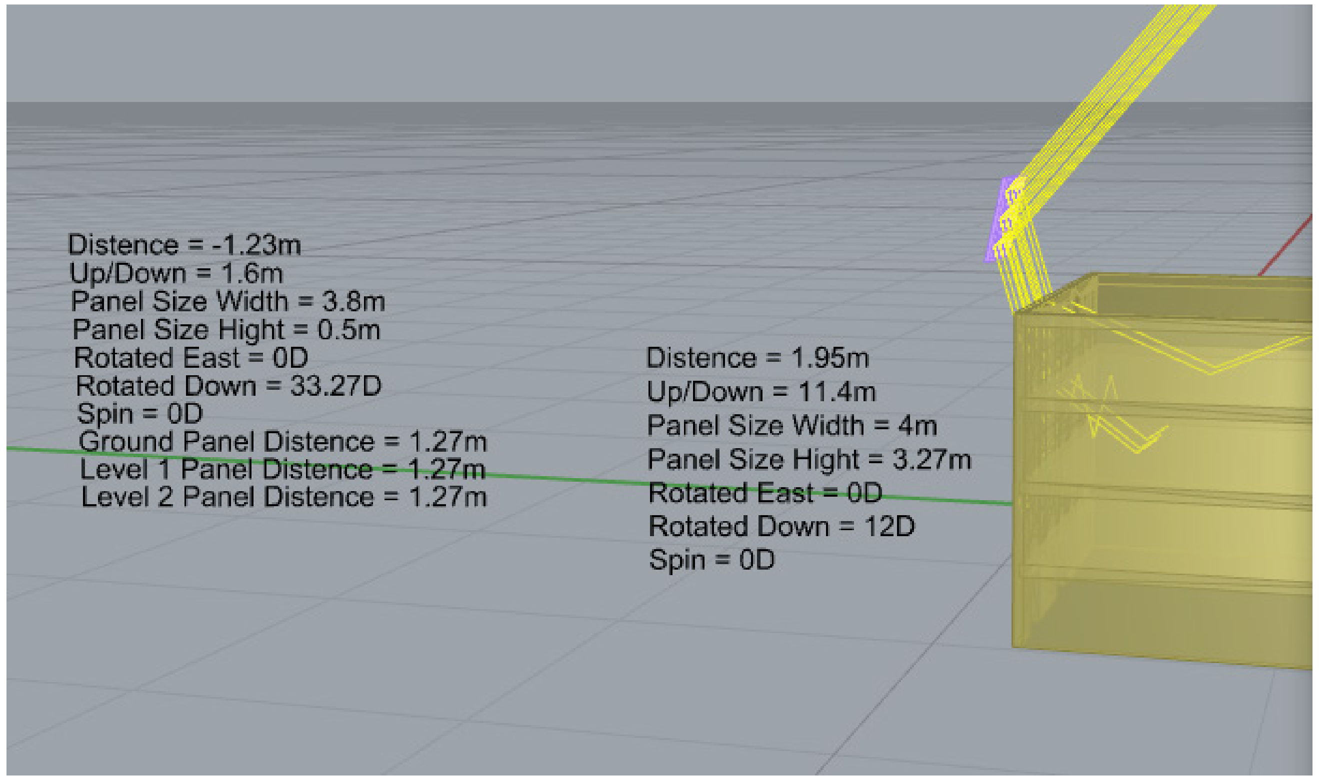


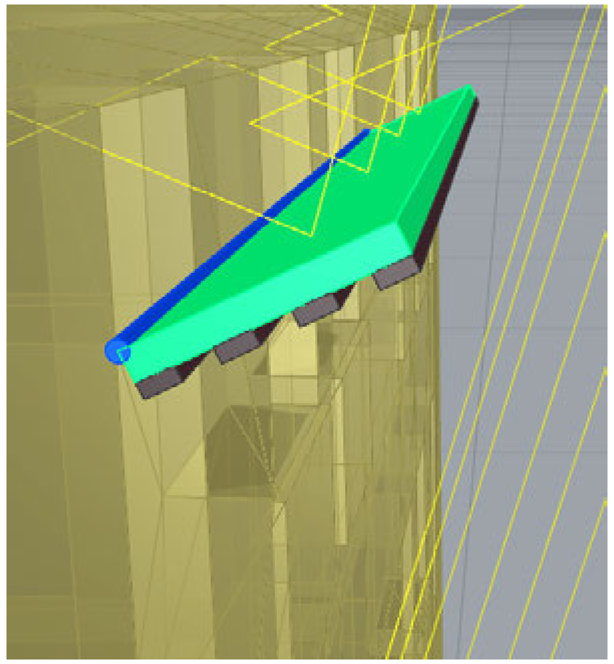



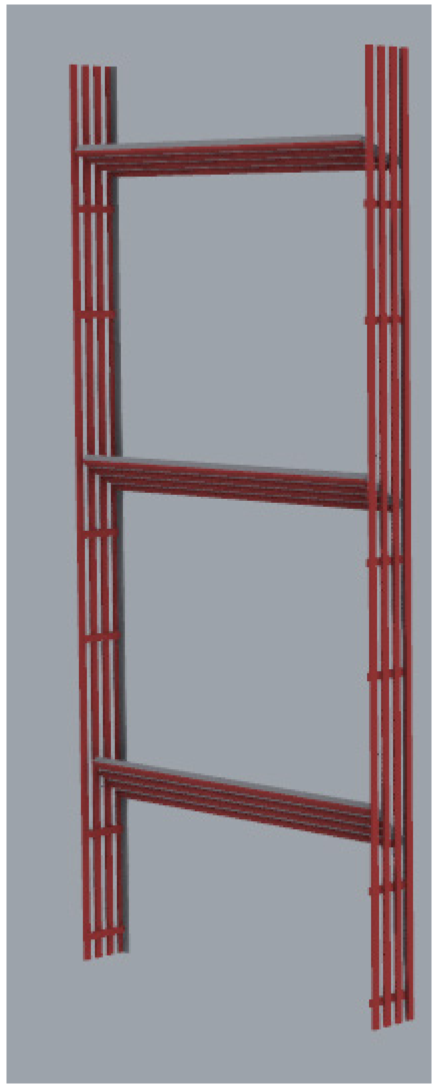



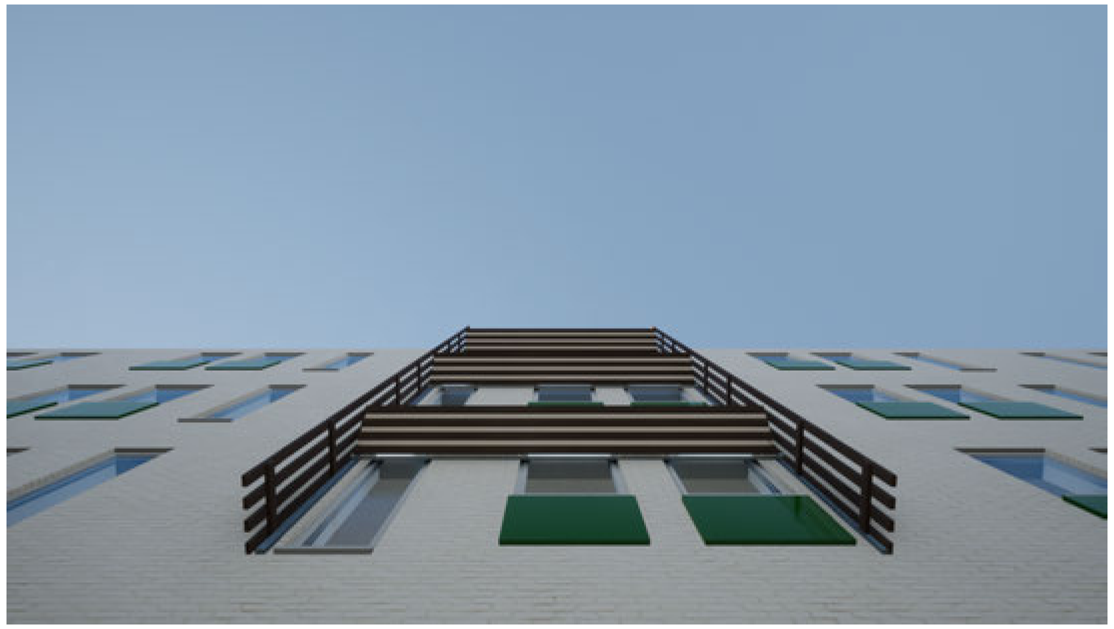



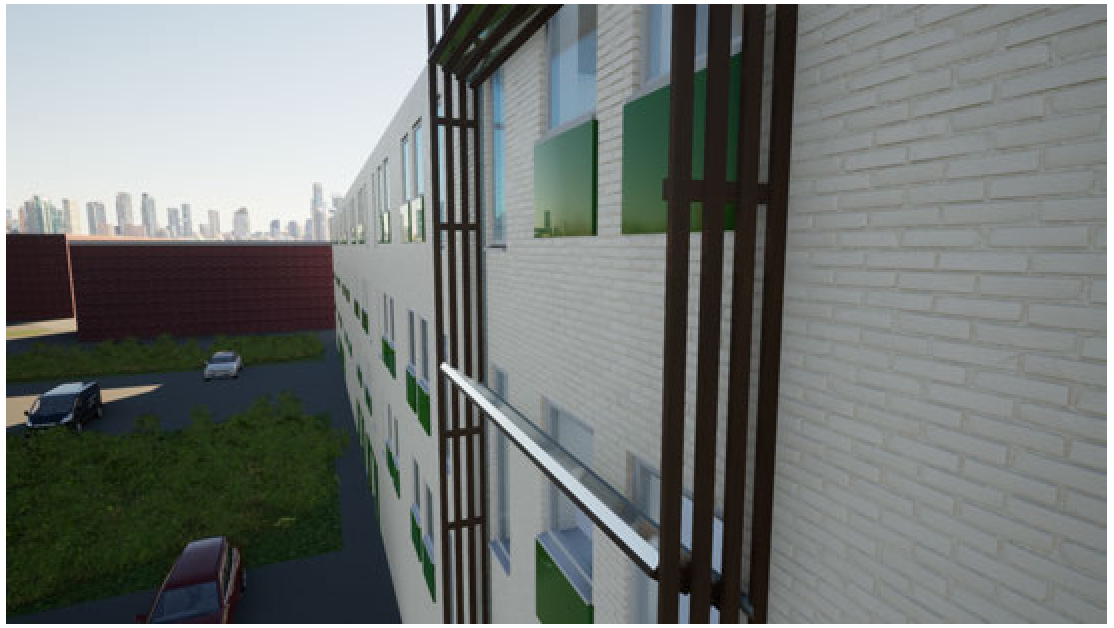
# Lower Mirrors

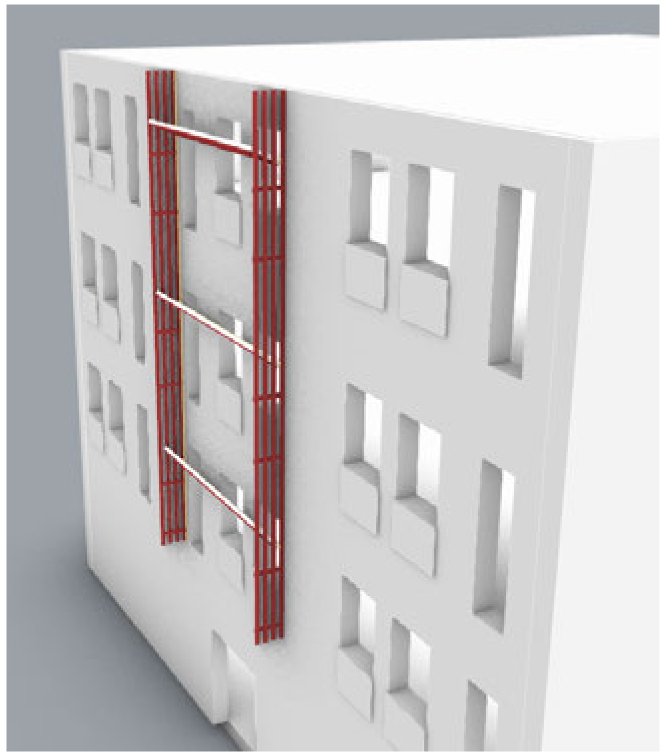
The lower mirrors will only need to be rotated up and down, because of this the design can relatively simple with one point of rotation. The mirror on each of the levels will require a different angle to get the best angle of reflection. The different between each of them will only differ by a few degrees, however all of them will need to rotate though out the day. Unlike the top mirror the number of degrees changed though out the day will be very minimal.
To hide the mechanical components and add to the aesthetic of the building a wooded panel system will go ether side of the moving panels. These have also been design to complement the top aesthetic.



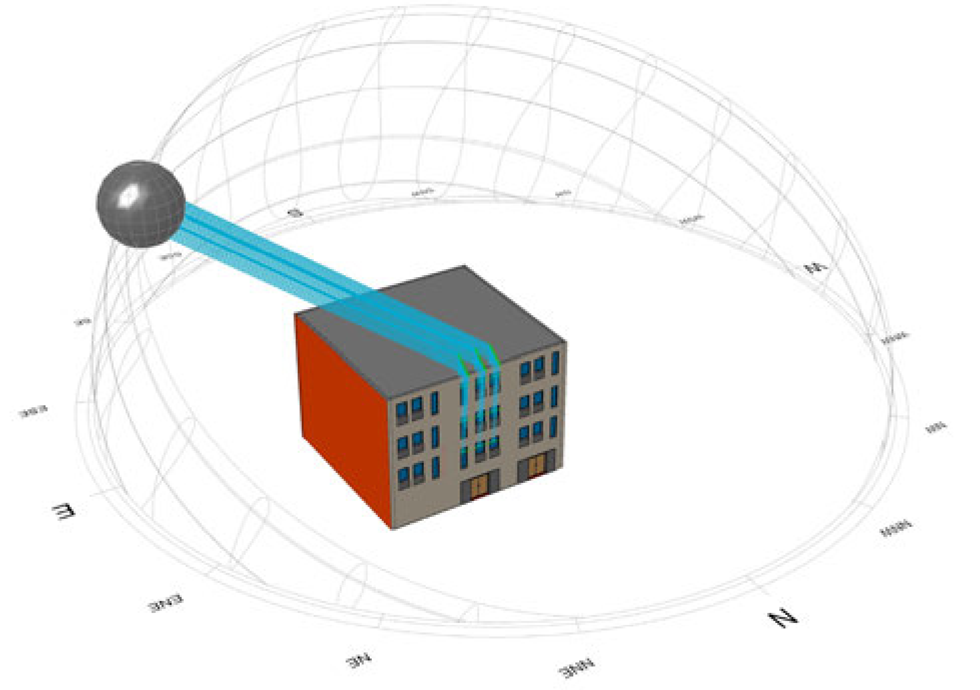






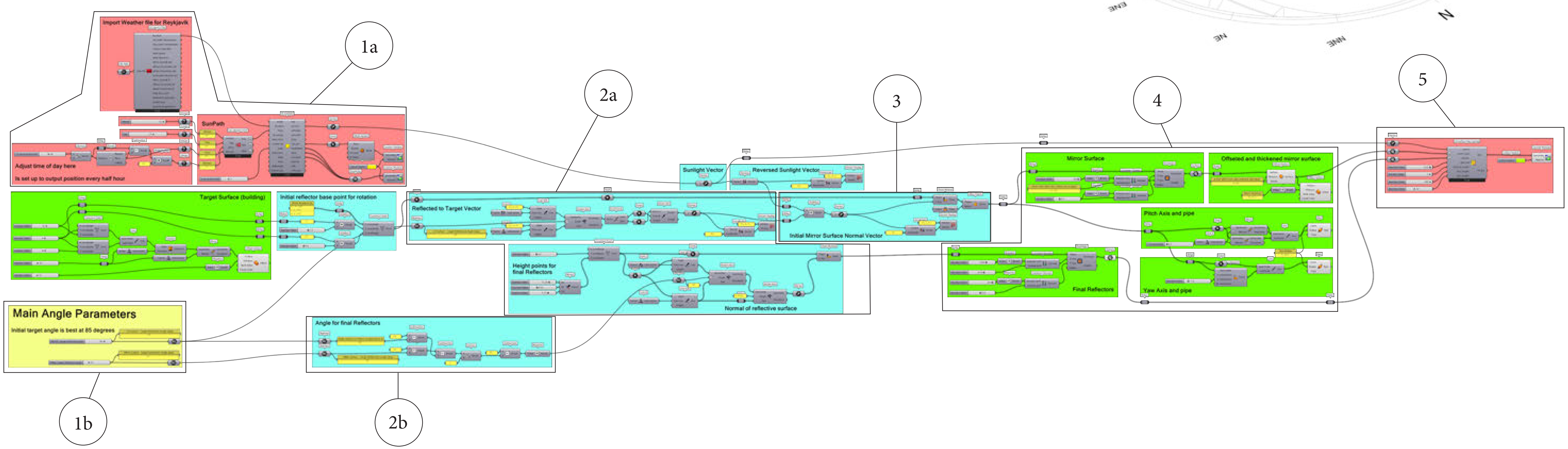


# Parametric Heliotropic Reflectors



Below shows the Grasshopper definition for determining the geometry and postioning of reflective surfaces for a heliotropic daylighting facade system for a north facing side of a building in Reykjavík, Iceland.

This uses LadyBug simulation components to import sunpath data and analyse sunlight reflections.




1a. Generate Sunlight Vectors based on LadyBug Sunpath Analysis through imported Weather file for location.

1b. Set the target reflected sunlight vectors for their initial and secondary reflections.

2a. Compute the surface normal vector of the initial reflectors based on the sunlight and initial target reflection vectors.

2b. Compute the surface normal vector of the secondary reflectors (louvers) based on the initial and secondary target reflection vectors.

3. Create Planes for initial reflectors which follow pitch and yaw axis constraints.

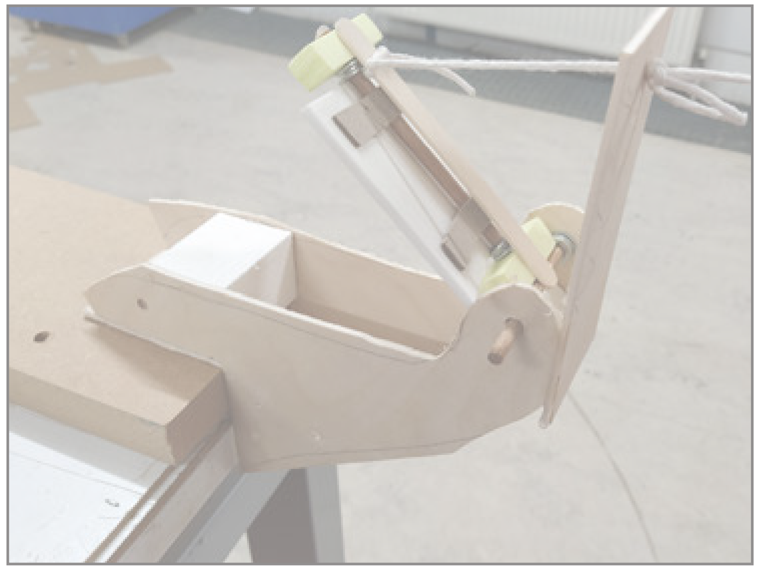
4. On reflector planes, construct geometries with appropriate dimensions and offsets for feasible fabrication and motion.

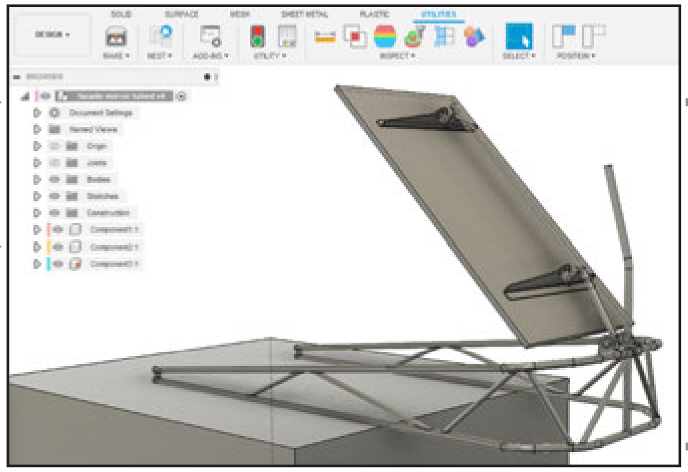
5. Simulate and Evaluate Sunlight reflections using LadyBug Surface RayTracing.

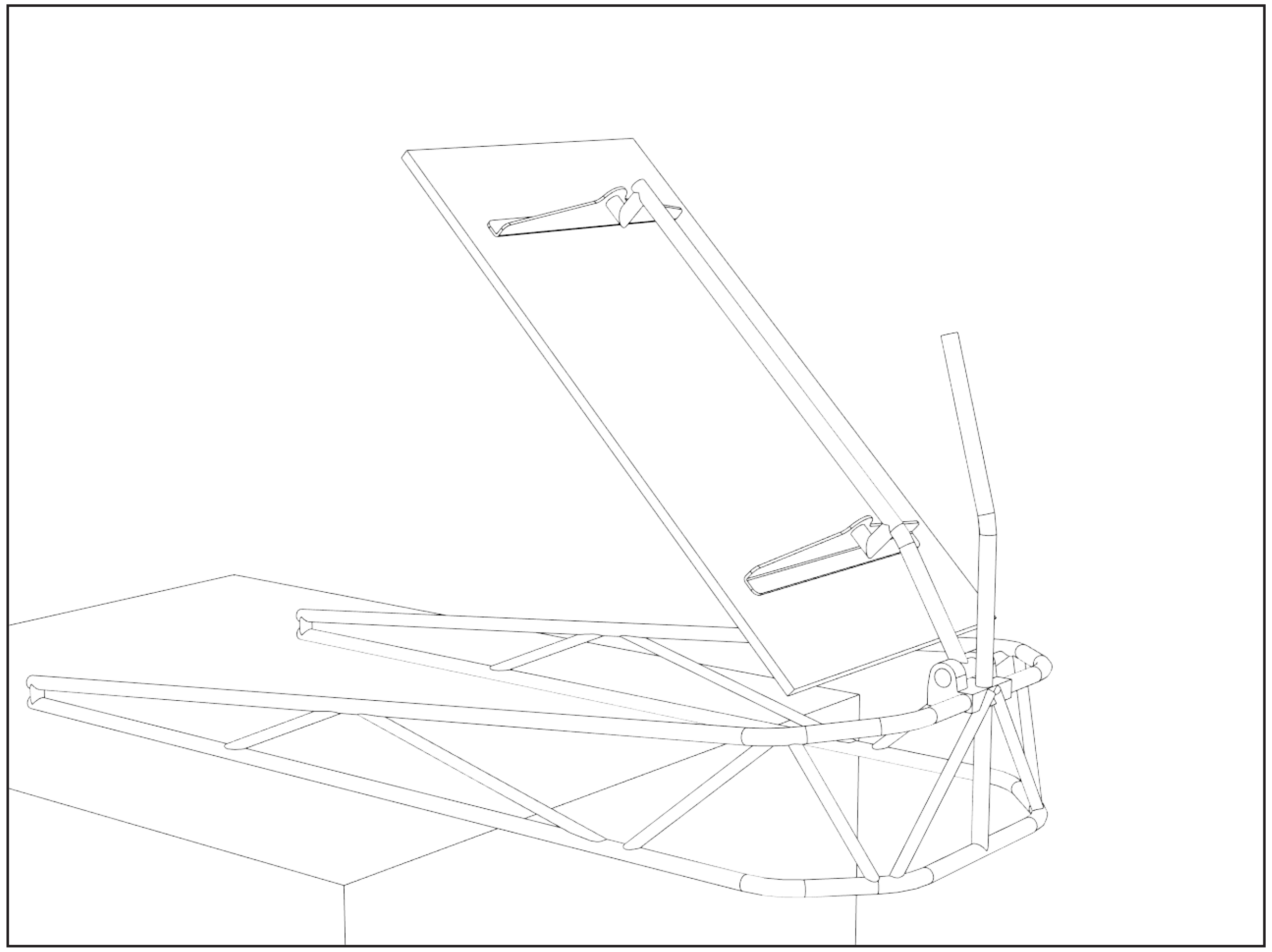
# Theory to Form

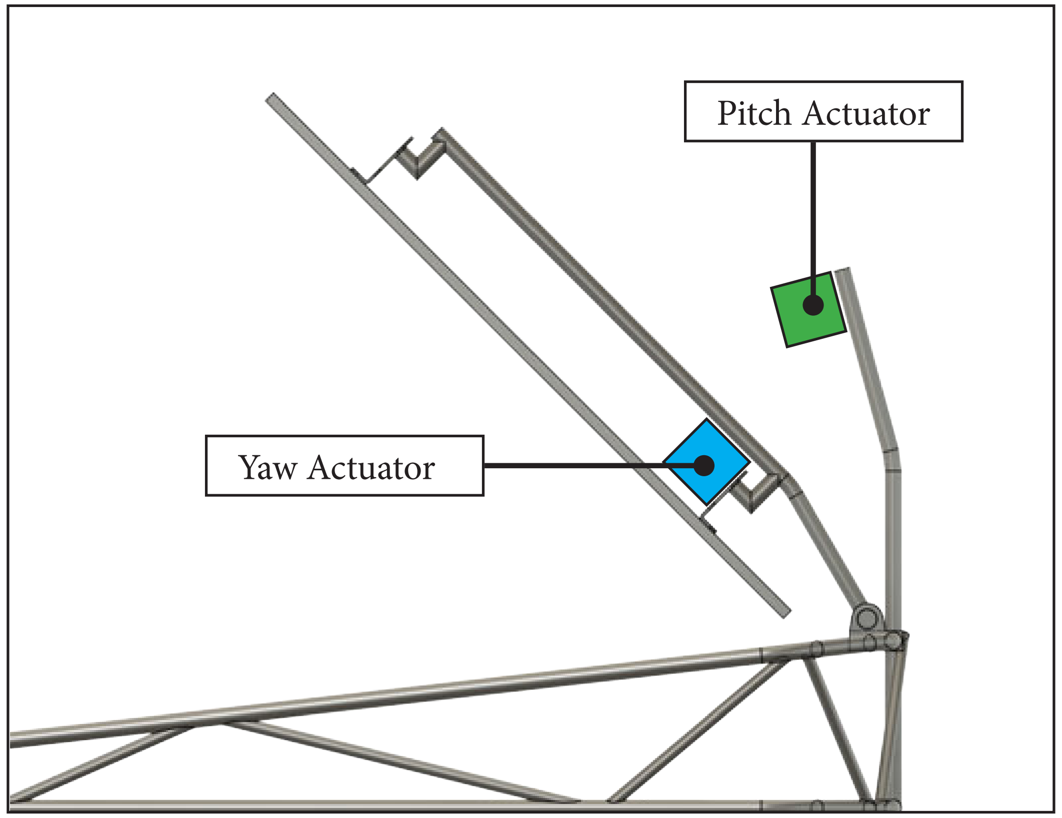
Floating Reflectors which re-direct light effectively are all great in the 'metaverse' where they have no real-world application. Fundamentally a method of physical assembly and operability must be proposed.

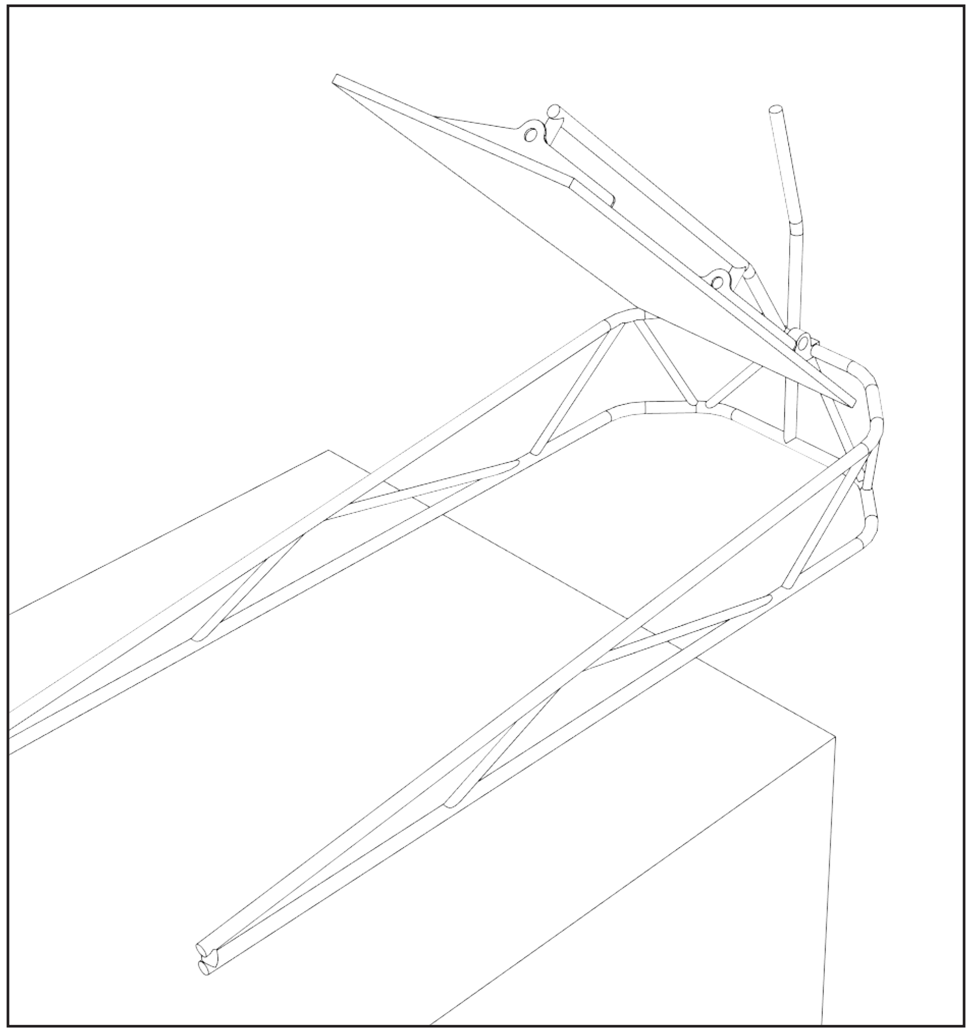
Using the 'Sketch Model' alongside geometry from the 'Parametric Heliotropic Reflector' grasshopper definition, a 3d functional model was constructed with appropriate material thickness, truss support frame and design space for Pitch and Yaw Actuators as detailed below.









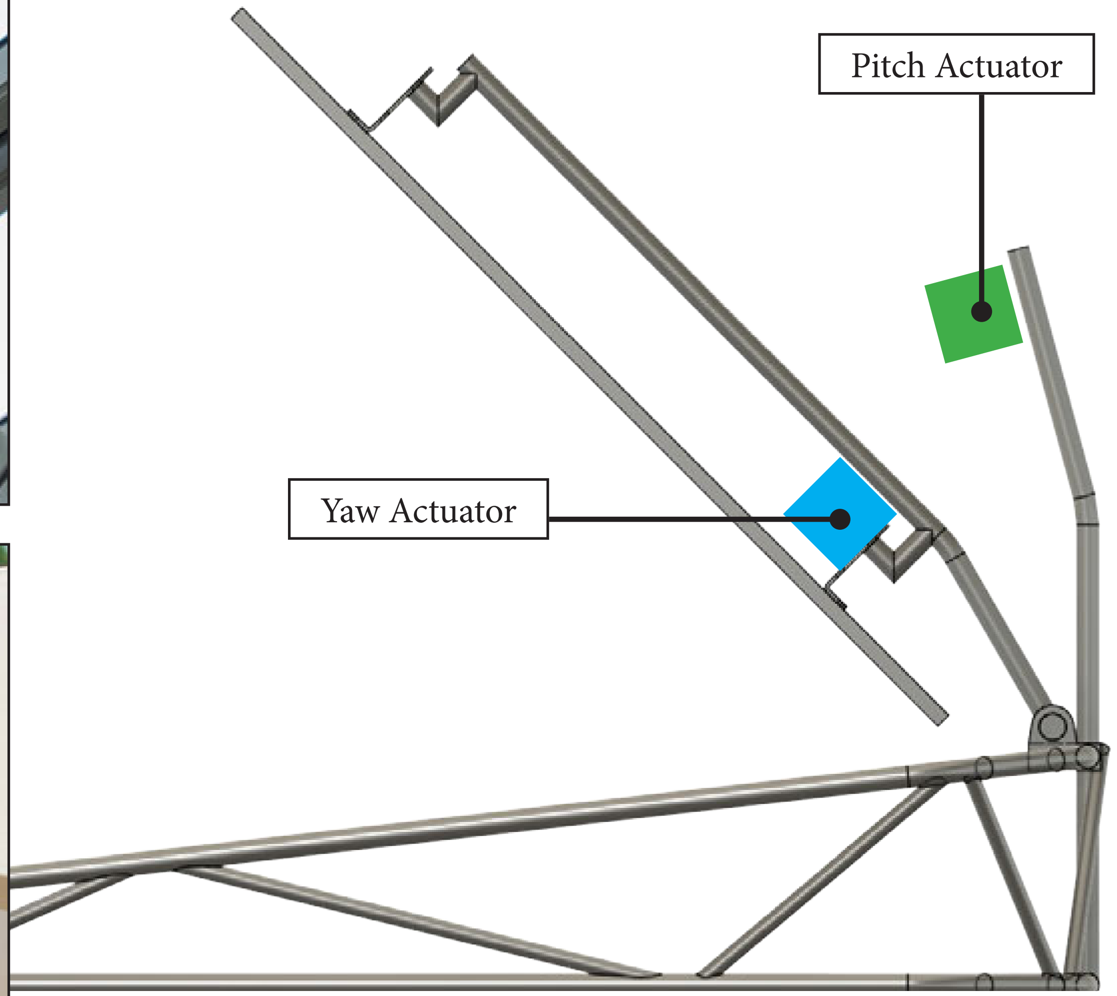
# Heliotropic Mechatronics

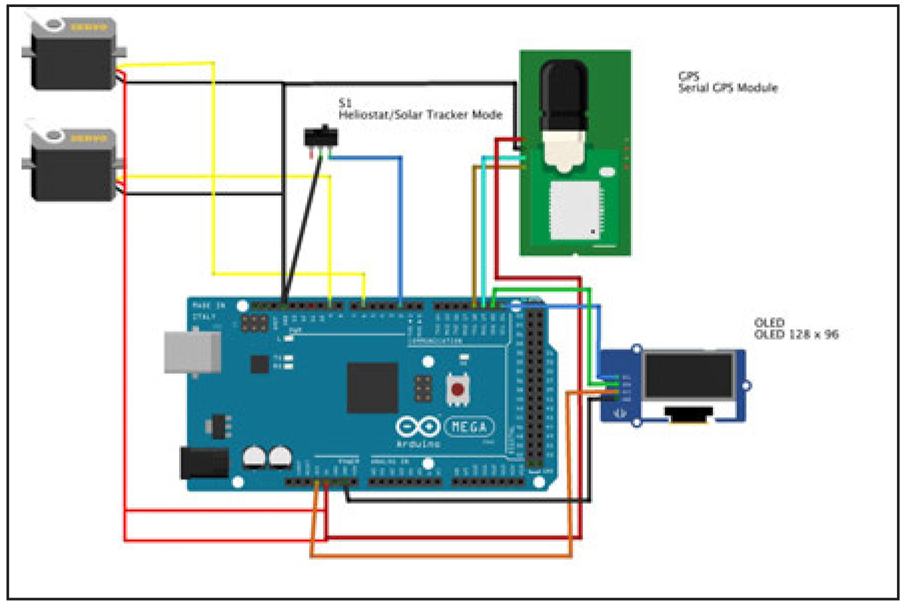
The Pitch and Yaw axis movements can be controlled and operated using Rack and Pinion mechanisms, which are widely used for example in dynamic greenhouse venting as seen below.

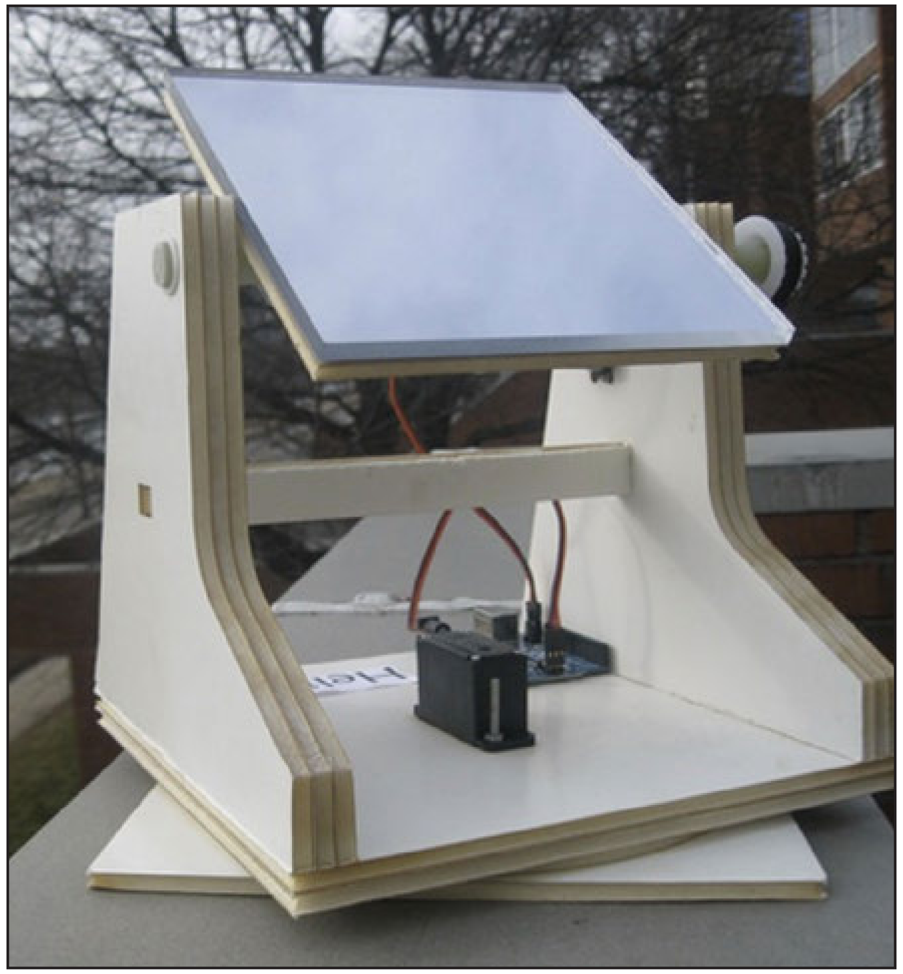
The precise positioning of the heliotropic reflector can be set using physical computing. Opensource projects, such as that shown right, use GPS positioning and Time & Date data track the sun positioning for dynamic Solar Panel movement, to maximize KWh harvest, using Arduino.

Similar projects could be adapted to position the heliotropic reflector using the rack and pinion mechanism.

Rack & Pinion Vent Actuators (Climate Controls, 2023)



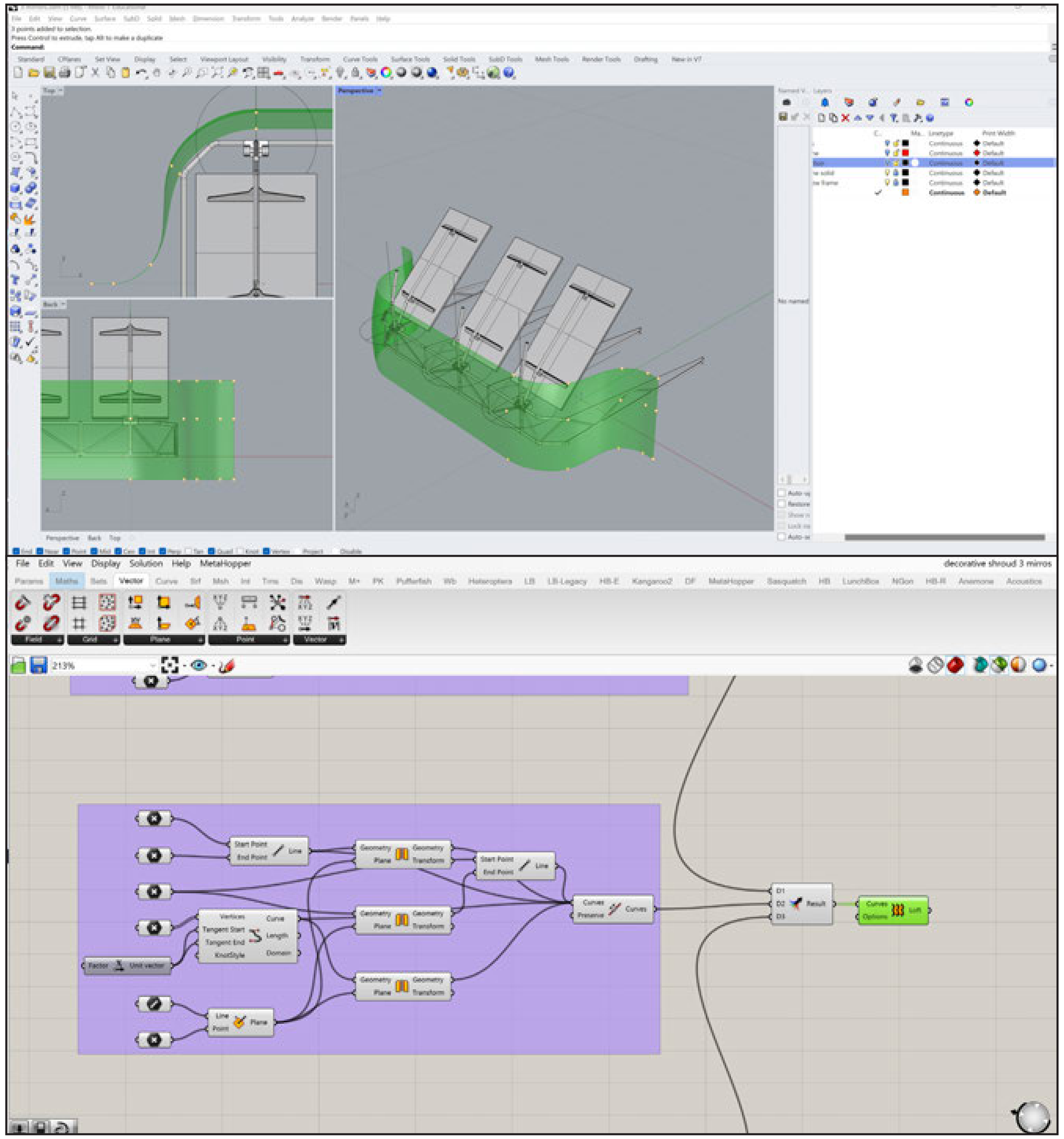
DIY Solar Tracker and Arduino configuration (pdaniel7My, 2014)

# Shroud development

1

Create lofted surface from planar curves.

Curves are controlled by points that can be manipulated in Rhino using gumball. Each curve is mirrored about a mid-plane of the reflective components i.e. mid-plane of bounding box.

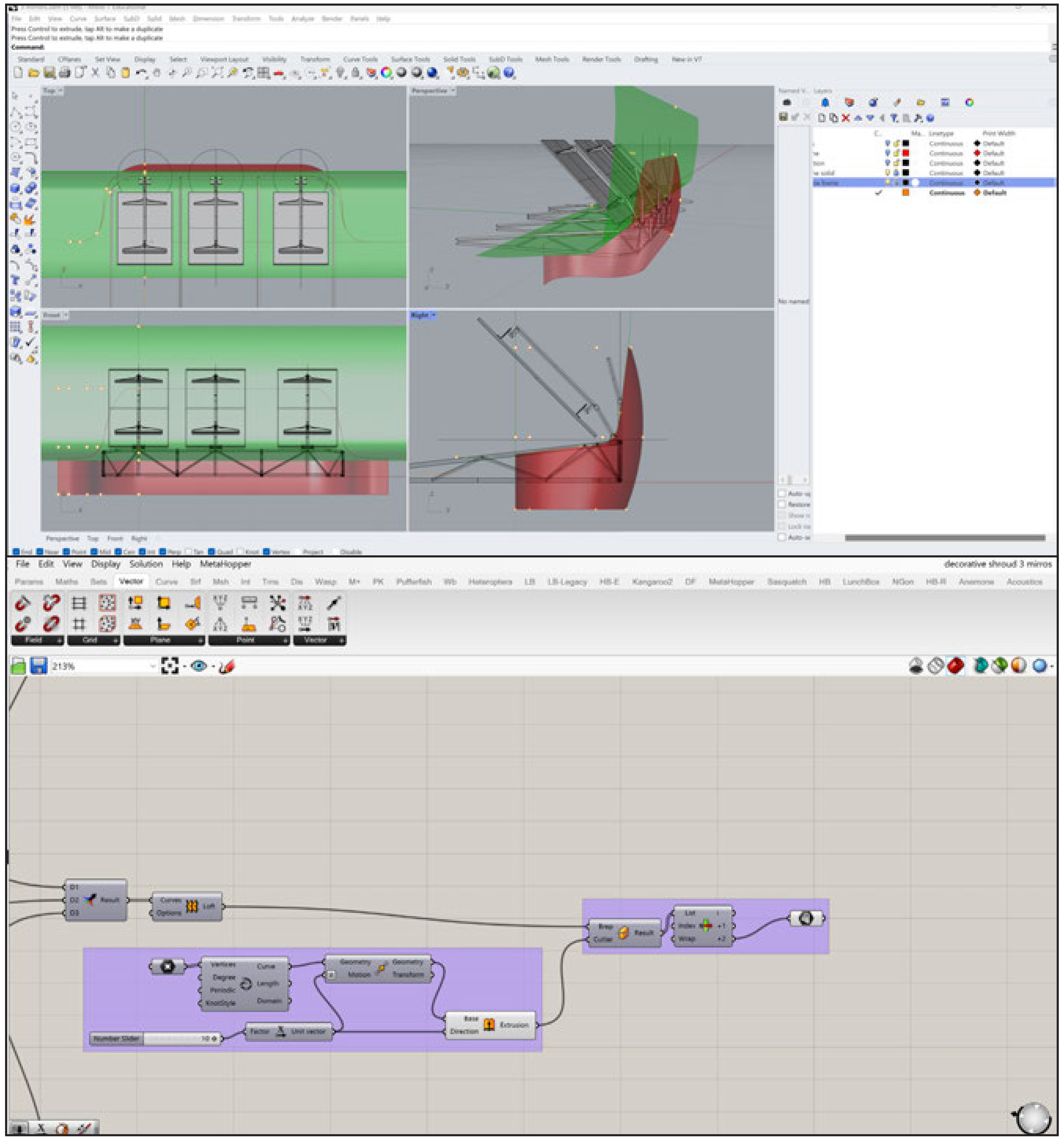


2

Split surface with surface to cut away sides of shroud, for operable clearance.

The surface used to split the lofted surface uses an extruded curve with control points again able to be manipulated in Rhino using gumball.

The desired surface is selected using the list item component.

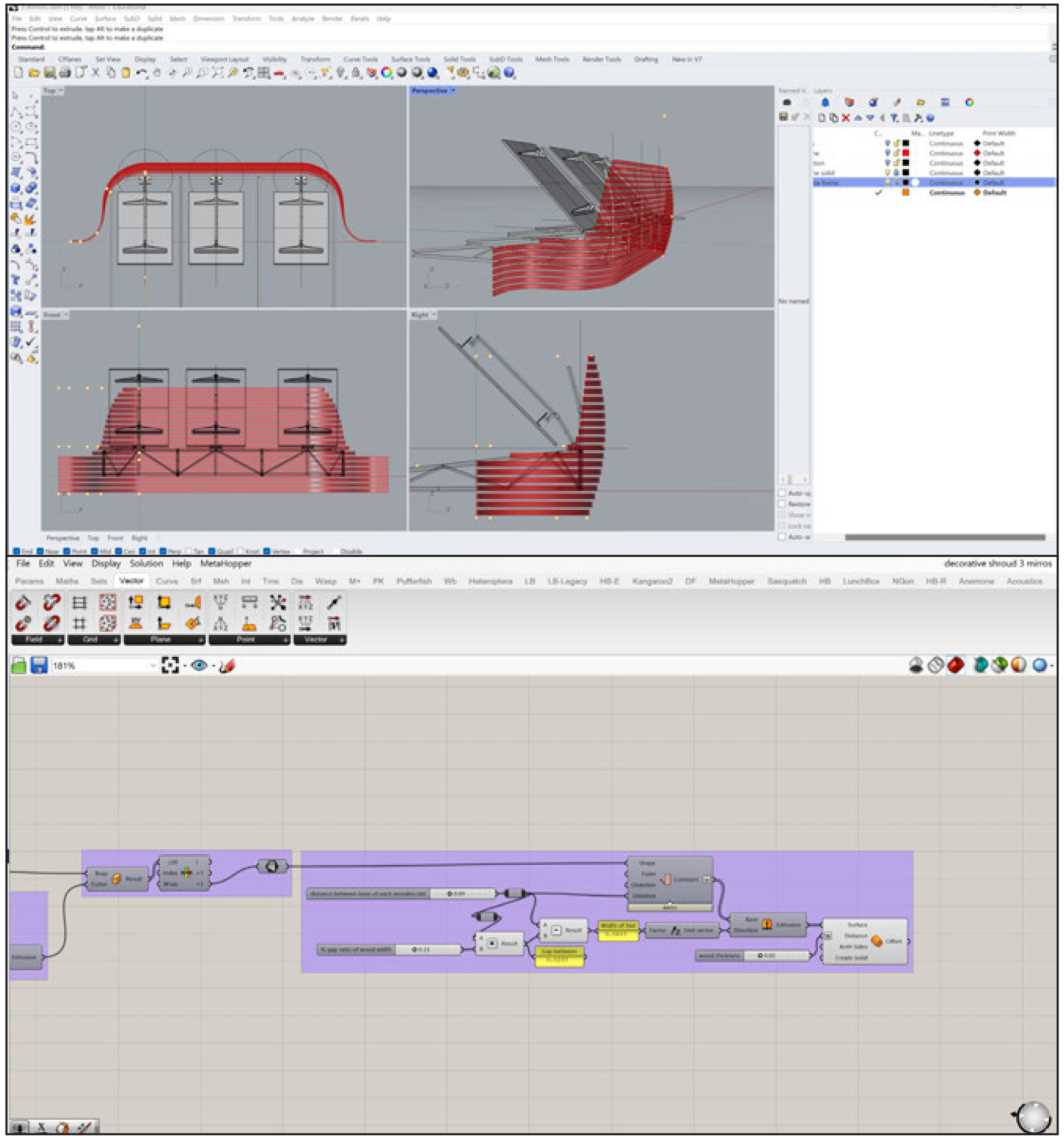


# Shroud development

3

Steam bent wooden Slat geometries are formed using the Contour component.

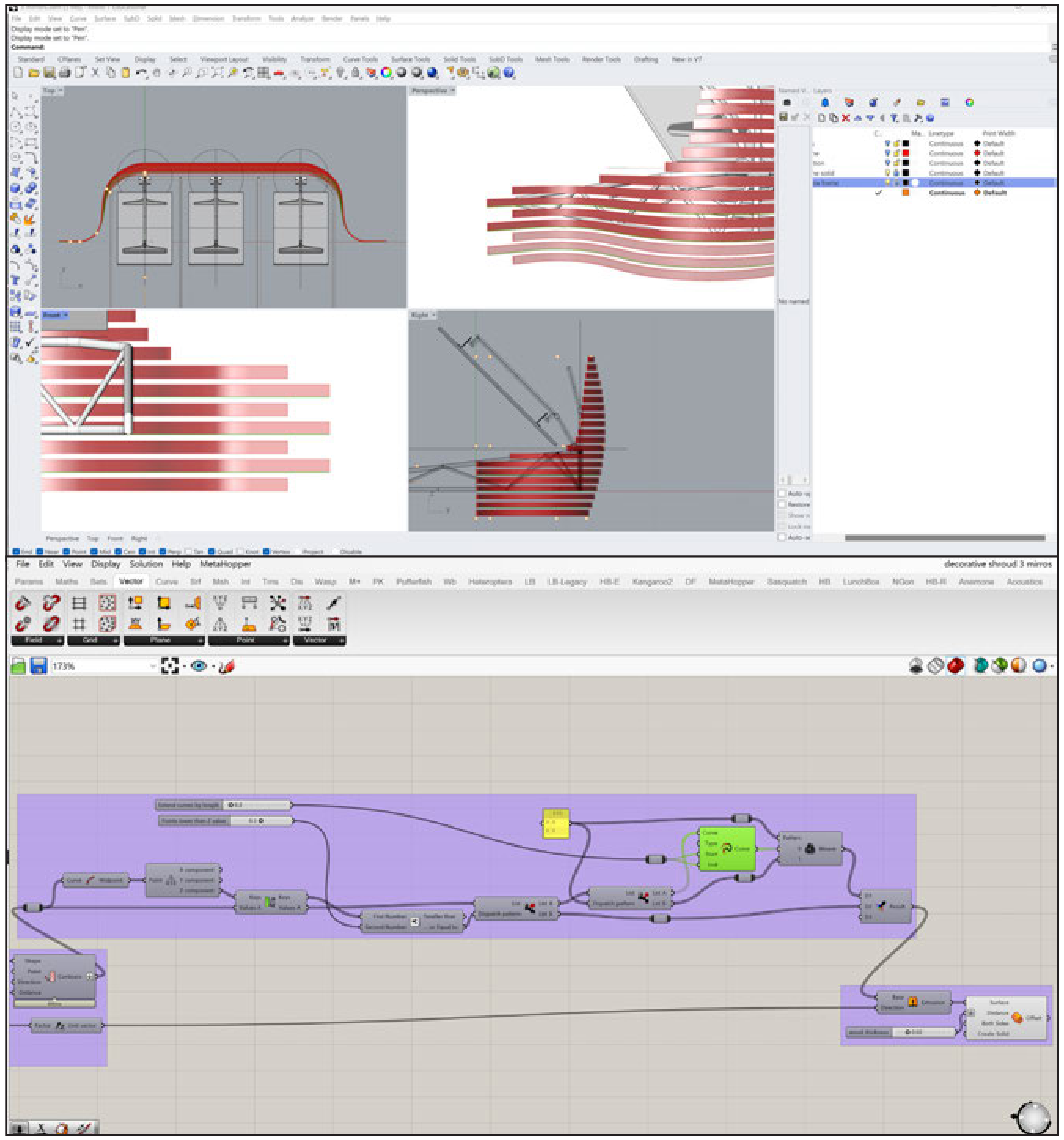
Contour curves are generated on the surface and parametric controls allow the distance between Slats, the proportion of gap to Slat coverage and thickness of Slat to be adjusted.



4

Extend ends of Slats in alternating pattern where slat ends are planar with building surface.

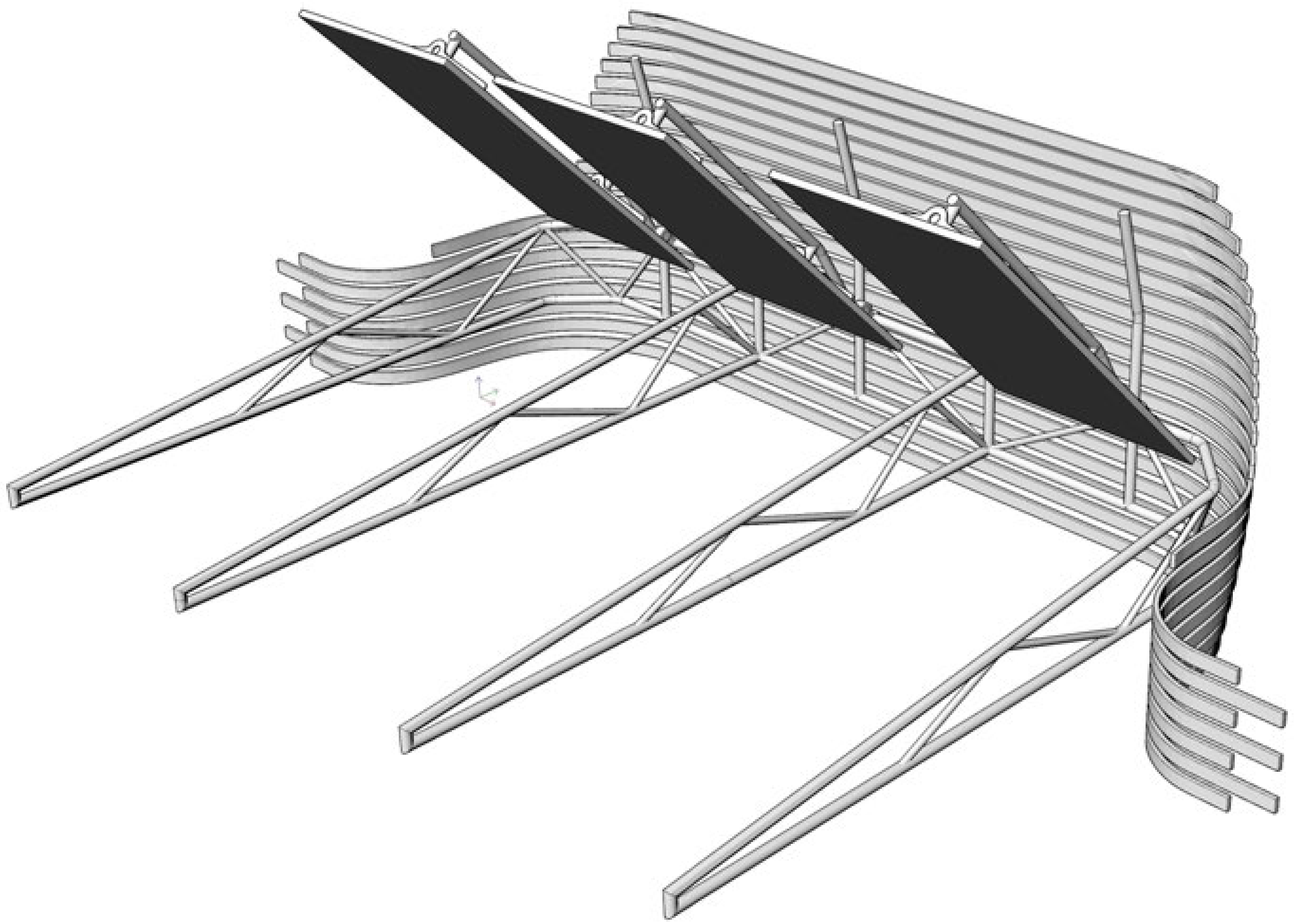
Sort contour curves by their mid-point z co-ordinate value. Select all contours below certain z value. Extend every other curve by distance sing a dispatch pattern. Recreate wooden slat geometries in previous step.

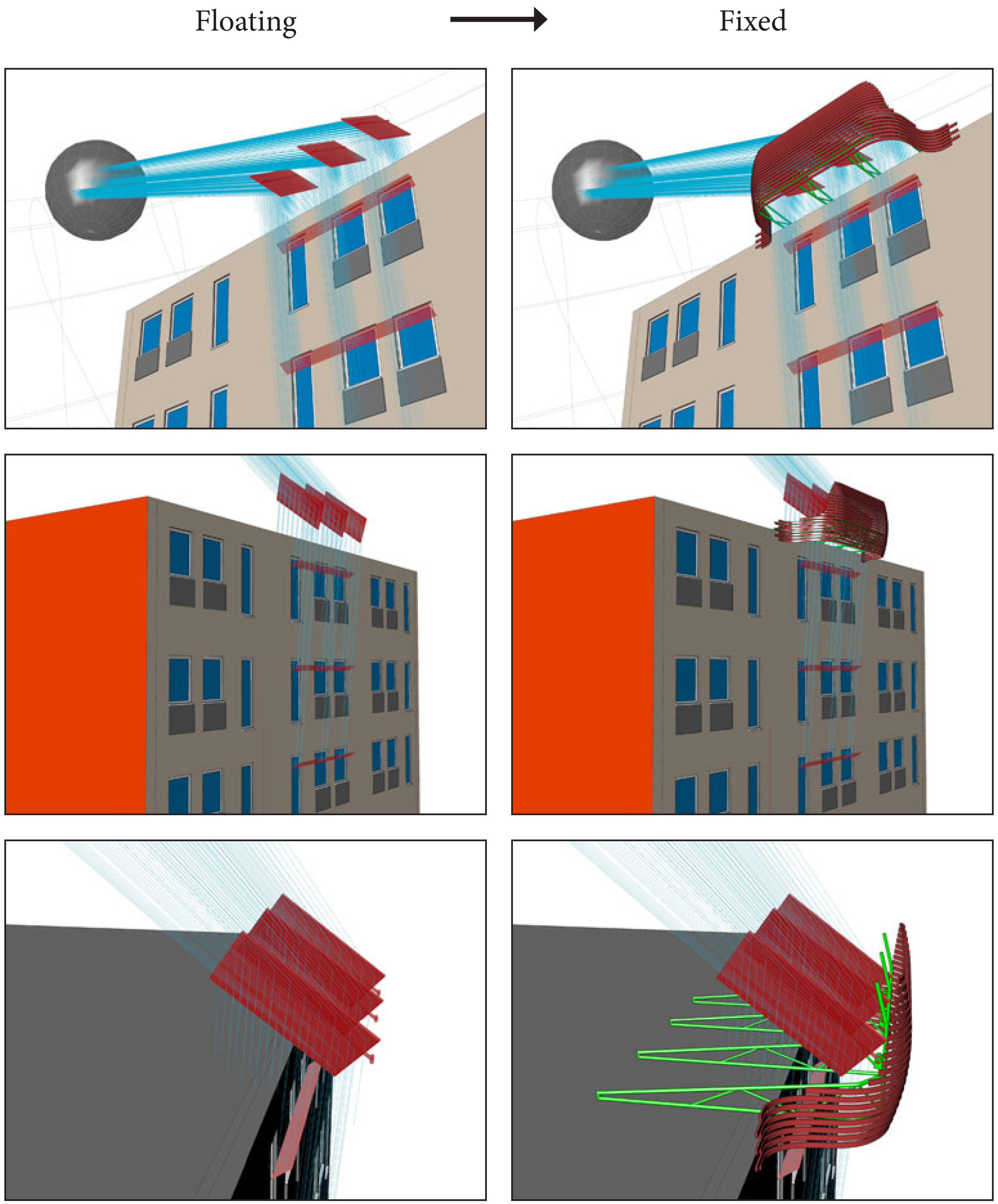


# Floating to Fixed

On the right we can see comparisons between the floating heliotropic reflectors to a system which supports and envelopes itself to the target building, allowing the sunlight to be re-directed towards the target window reflectors.

The final assembly with developed slatted shroud and truss frame can be seen below.





# Retrofit Heliotropic Daylighting Facade

Scalable and adaptable - multiple reflectors and shrouds can be positioned in line with pre-existing windows, daylighting north facing rooms and blending into the fabric of the building.

# Retrofit Heliotropic Daylighting Facade

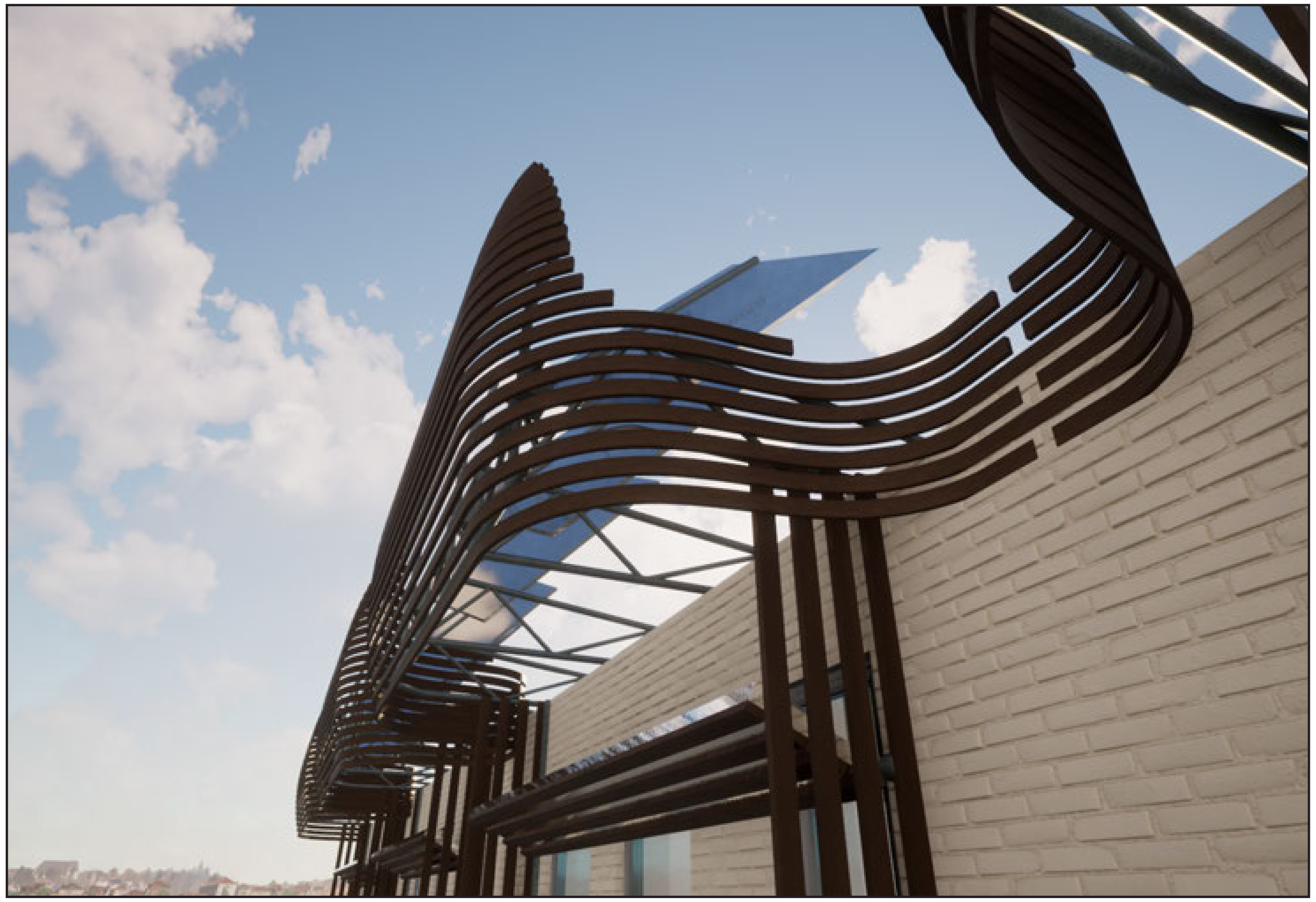
‘Good design is as little design as possible’
(Dieter Rams)

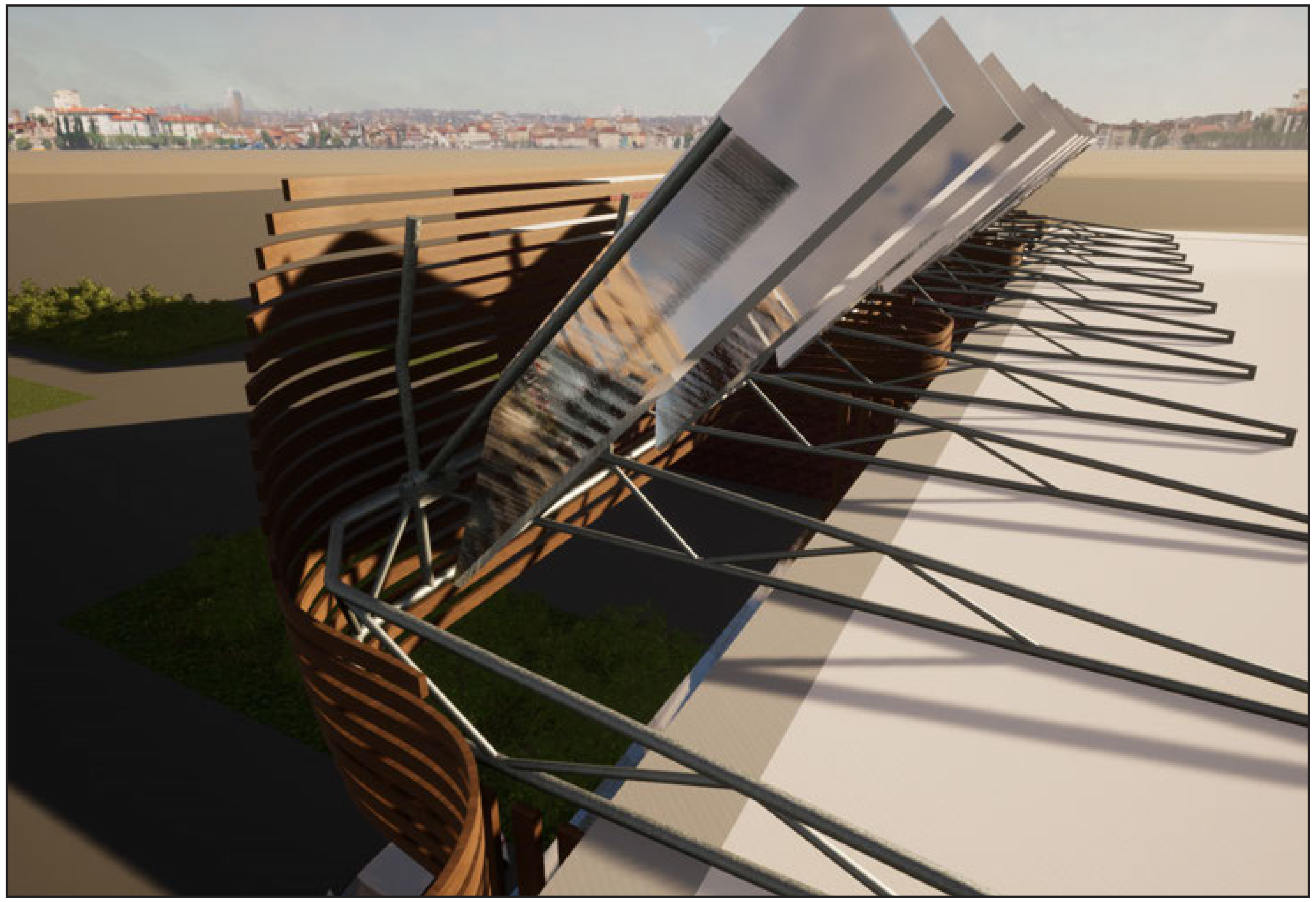
The system uses a dynamic heliotropic reflectors which adjust their position based on their geolocation, time and date to track the position of the sun.

Static secondary reflectors positioned outside the top of northern facing windows reflect light redirected from the dynamic reflectors into the north facing rooms towards the ceiling for to passively daylight otherwise shaded north facing rooms.

The shroud which transitions its wooden slat design language into the secondary reflector frame, offers more than a decorative camouflage. It’s equally important design intent is to offer wind buffer protection to the mechatronic components and the dynamic reflectors which would suffer from becoming sails in high winds.

Further development of the shroud would be to test the effectiveness of the shroud as a wind buffer and alongside considering potential design fail safes such as resting the dynamic reflects to a ‘safe’ position during high winds, and or wind diverting components on top of the building.



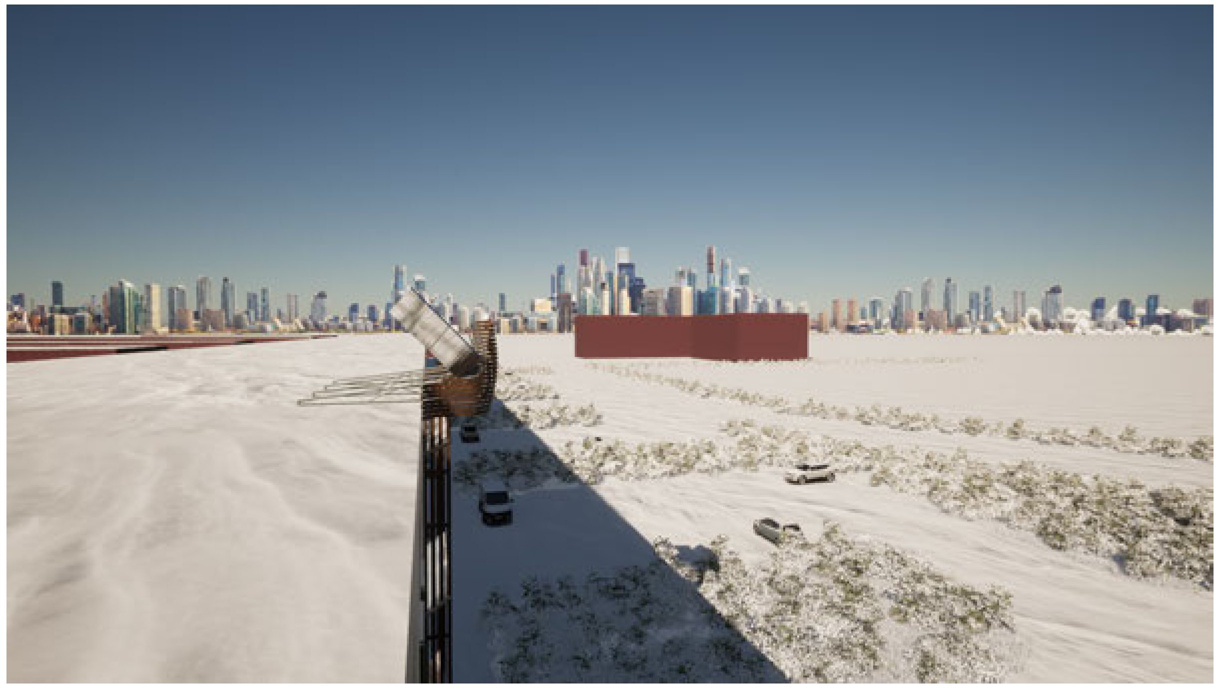
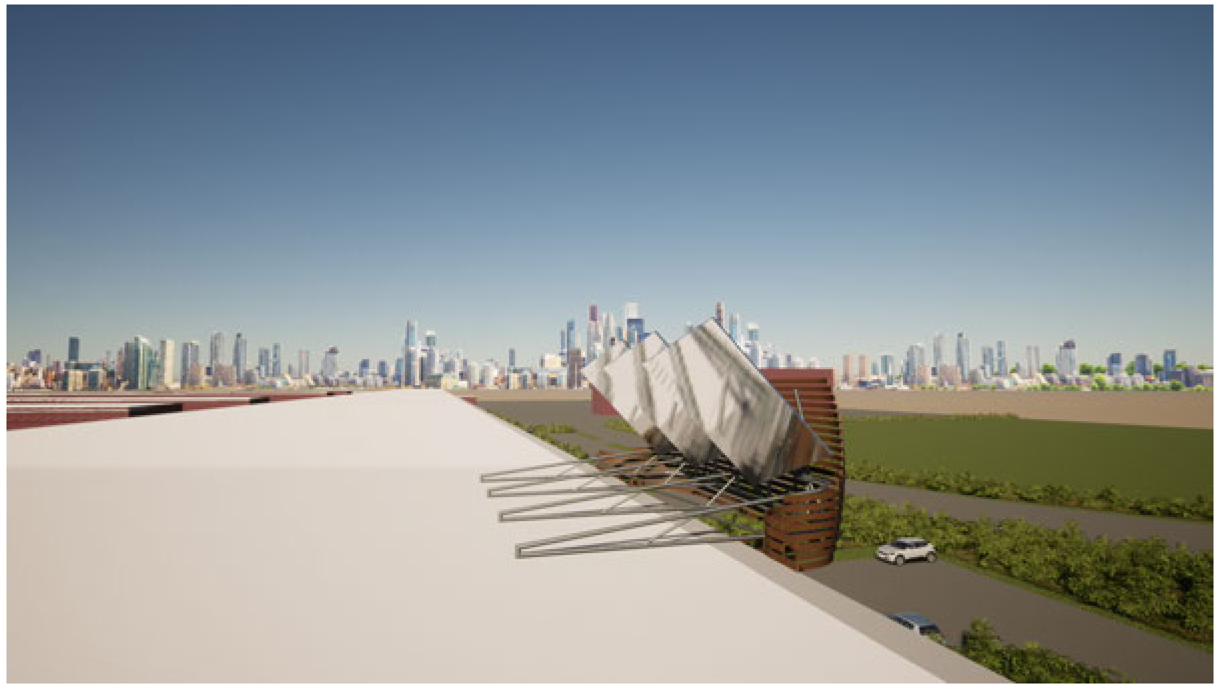


# Spring 21st March 10:30

In this test looking at the inside space the images below show the same room both with and without the top mirror outside reflecting into the room. The Imagines on the left are with and on the right without.






# Summer 21st June 10:30

In this test looking at the inside space the images below show the same room both with and without the top mirror outside reflecting into the room. The Imagines on the left are with and on the right without.






# Winter 21st December 13:00

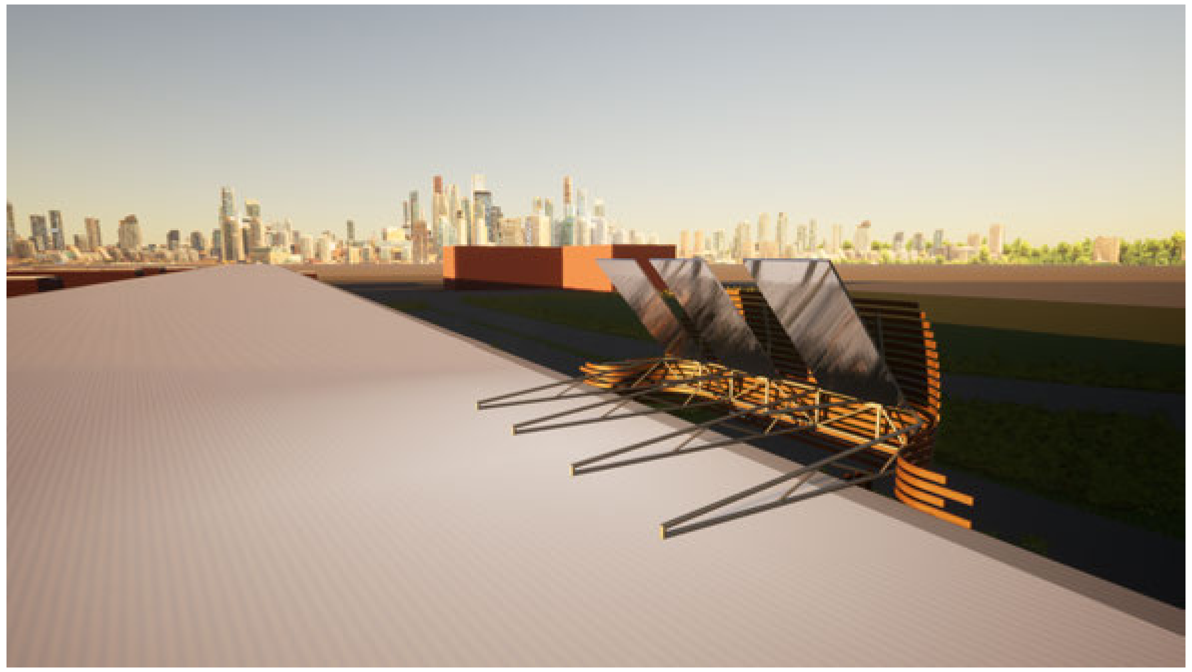
In this test looking at the inside space the images below show the same room both with and without the top mirror outside reflecting into the room. The Imagines on the left are with and on the right without.



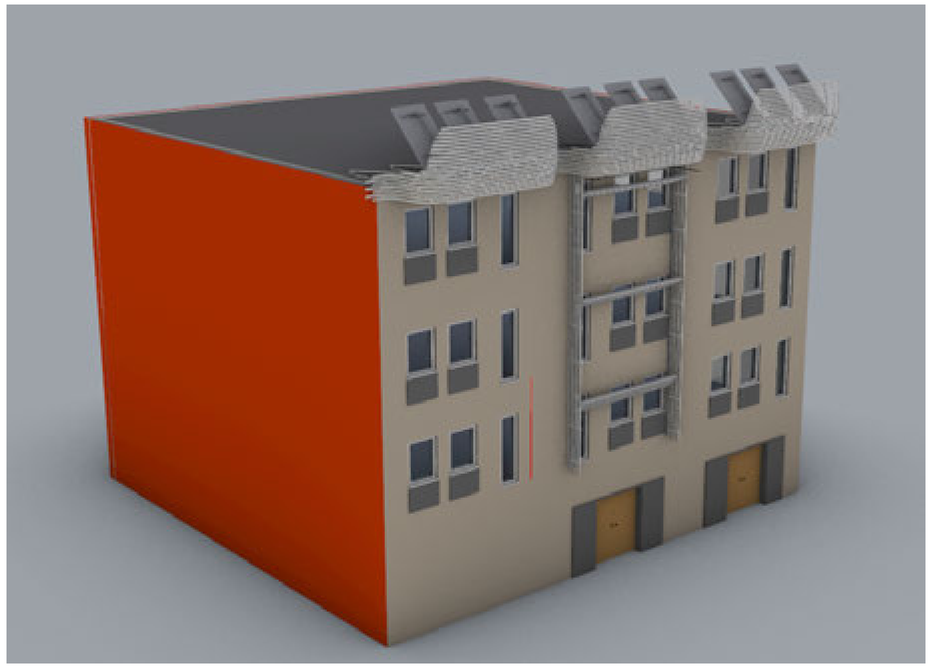


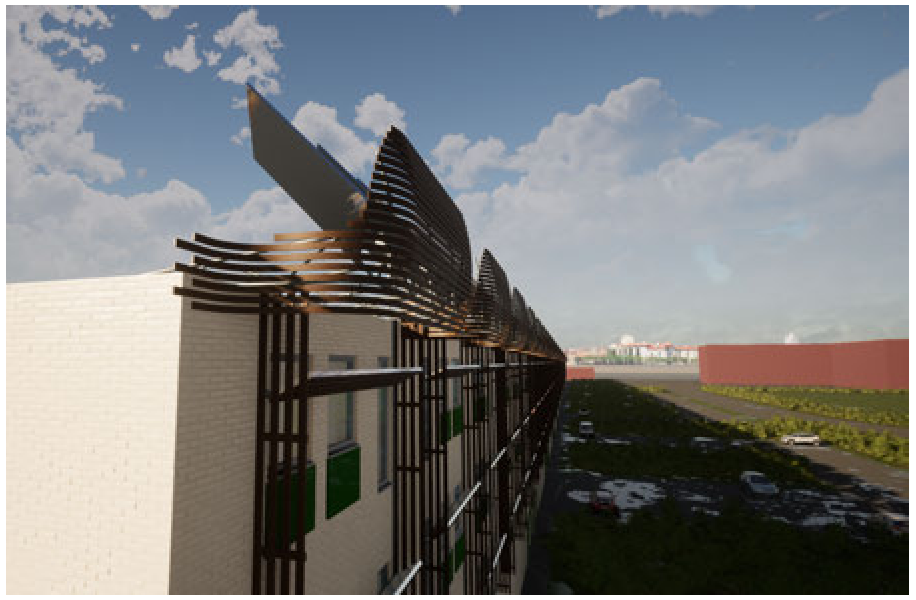






# Additional Renders





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