The Element office building: control strategy for movable external elements

The project

The Element office building is an exciting 14,000m² prime development in Maroussi, Athens. The Architects are SPARCH, while Arbitrage Real Estate is acting as Project Manager on behalf of Prodea Investments. Inform Design were involved as Building Physics and Façade consultants, in order to advise on proper solar control strategy. The solar protection was provided by movable perforated external screens, designed as a part of the Architectural concept for solar protection for the South-East and South-West highly glazed façades.

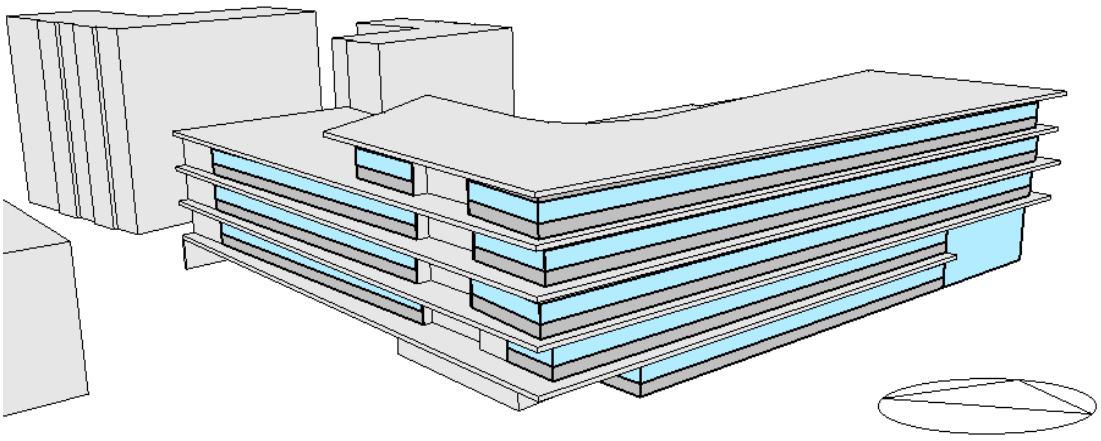
Challenges

To advise on solar control strategy Inform Design faced the following challenges:

A. How do we model **movable, angle dependant, perforated, external shading elements with high reflectance values?**

B. How can we inform a **shading control strategy** that can accurately predict the amount of transmitted solar radiation (based on weather station readings for beam and diffuse solar radiation)?

Our project contribution included suggesting (a) design characteristics (perforation, depth and in-between distance) for the screens that are in line with the Architectural intent and the set solar performance requirements and (b) shading control strategy to ensure real-life well performing façade.



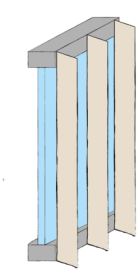
View of the DesignBuilder Model including shading from surrounding buildings

A. Model angle dependent and reflective external shading elements

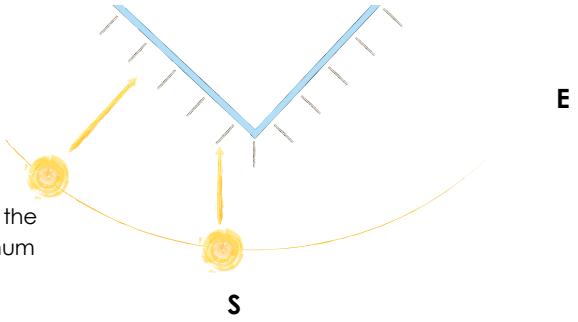
There were 3 important factors that we had to account for: (1) angle dependent performance; (2) elements' reflectance and (3) elements' perforation.

1. Angle dependent performance:

The **solar performance of the external screen depends on the incident solar angle** (as shown in the image below) and varies during the day. Therefore we used DesignBuilder to model the external movable screens as vertical slatted blinds and properly assess the façade system's solar performance on hourly basis. For façades systems with angle independent solar protection (e.g. roller blinds) assigning a g -system value (as some DTM software tools do) would be sufficient, but in this case such modelling would be inadequate.

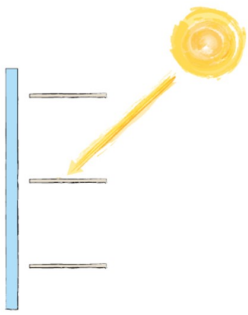


Movable external screens

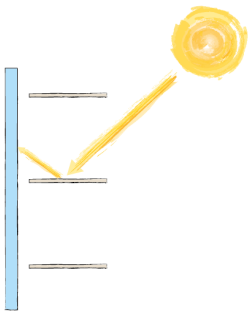


During afternoon hours the screens will have minimum shading effect

Around noon the screens will effectively shade the facade



DTM tools not accounting for the reflectance of external elements



With 70% reflectance the screens will reflect significant amount of the radiation

2. Reflectance of shading material:

The **elements' material** was selected by the Architects to be **highly reflective** (with 70% reflectance). **If we don't account for this reflectance we would underestimate the solar gains**. Based on our experience, EnergyPlus is a DTM software tool that can account for the reflected solar radiation from external elements. We used DesignBuilder as a well validated and user friendly interface for EnergyPlus.

3. Perforation of shading screens:

The shading screens are **50% perforated**, which means that they would not fully block solar radiation. We caried out several sensitivity tests using DesignBuilder and modelled the screens as vertical **slatted blinds with 50% transmittance**.

B. Developing shading control strategy

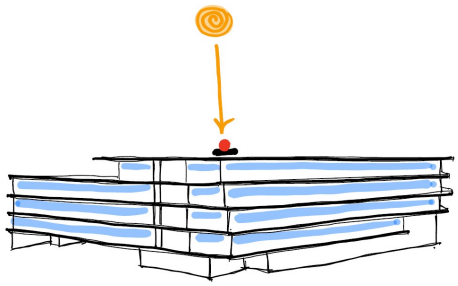
The second task was to suggest a **shading control strategy** for the external screens, that would **ensure good real-life performance** (reduce unnecessary use of shading).

Our challenge was to develop a control logic that can (a) use a roof based weather station that reads the beam and diffuse solar radiation, (b) predict the expected transmitted solar radiation through different façade parts and (c) provide the right input to the control system.

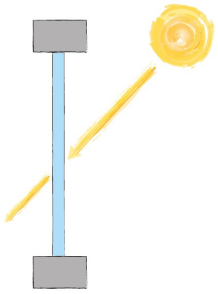
Using DesignBuilder we were able to (1) extract custom output variables and (2) define small simulation time steps. This could in real life allow us to link the installed equipment with the existing control strategy.

1. Custom output:

As **DesignBuilder allows the user to select the variables to be reported** we were able to pre-predict the beam and diffuse solar radiation to be transmitted through every time step of the year. We then corelated this data with the real-life measured data from the weather station in order to provide shading control strategy.



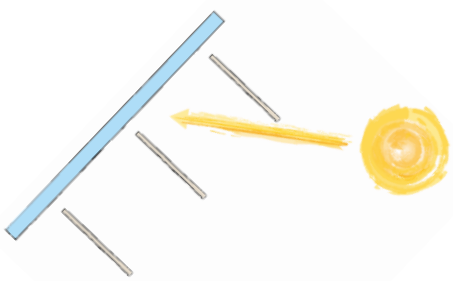
Weather station on the building's roof reads the beam and diffuse solar radiation



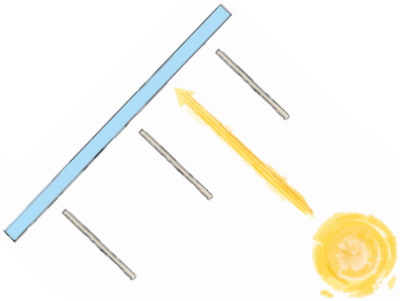
Corelate weather station readings and the control logic

2. Time step definition:

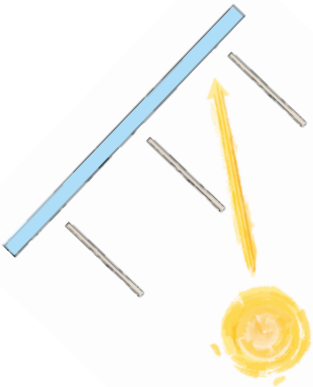
Essential to our process was selecting the timestep (10min). This was necessary as the incident solar radiation falling on the windows (behind the external screens) depends on the solar angles and the shading effect of the screens, as shown in the Images below. Selecting larger time steps (1 hour) would reduce our resolution and potentially not allow us to identify and report peaks in incident solar radiation. Therefore we would not be able to properly size the need for solar protection.



Incident angle at 10:00



Incident angle at 10:30



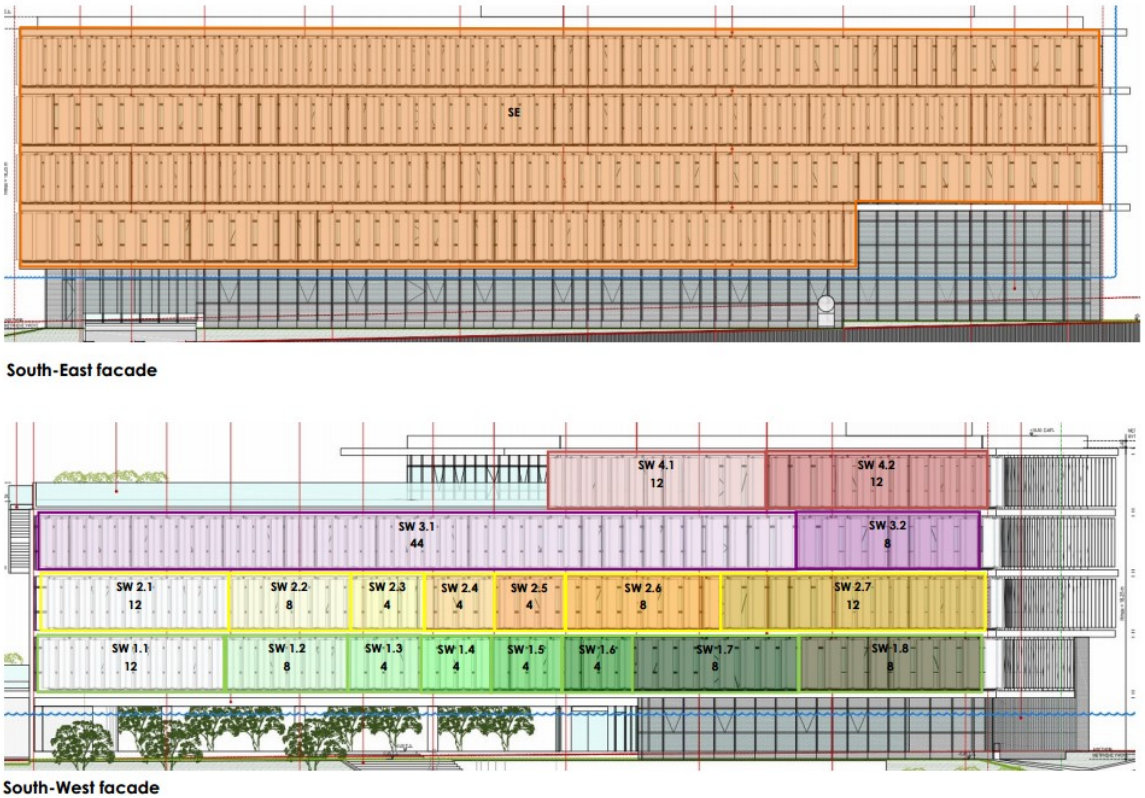
Incident angle at 11:00

Shading control strategy

The shading control strategy we developed in this project was based on readings for beam and diffuse solar radiation from a weather station. Those readings are accurately corelated to solar radiation expected to be transmitted by the glazing.

The external screens' default position is perpendicular to the façade, allowing for views out. When the expected transmitted solar radiation exceeds the limits set by the M&E engineers the screens track the sun.

As part of the shading control strategy we also suggested banding of screens; accounting for the shading effect of surrounding buildings. We divided the movable screens in groups that can be controlled together, as shown in the Image below. The aim was to avoid closing the screens too often in shaded façade areas and unnecessary harming views out.



Façade division in bands of screens controlled together

About Inform Design

Inform Design AB is a consulting practice, founded in January 2017. Our field of work is in Facades, Building Physics and Indoor Climate assessments with an emphasis on highly glazed constructions. The focus of the practice is to inform architectural design supporting it with advanced technical knowledge and to ensure high quality buildings. More information on www.inform-design.se