Characterised sun path patches as a way to design better shading

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Abstract

A discovery process that started with how architects use 3D models to design shading identified a substantial portion of practitioners who do not do any thermal simulation to design shading.

This was found to be caused by difficulties in both drawing conclusions from the outputs of thermal simulations and explaining them to clients.

We then used the beta program to test a range of design options, including 3-colour sun-path diagram plus star rating, to see if it improved understanding.

Initial feedback and findings are that this has substantially improved evaluation of shading strategies.

Key Innovations

- Three-tone colouring of sun-path diagrams combined with reverse shadows aides comprehension of shading strategy effectiveness
- Star rating based on a concept of the amount of “detrimental” and “beneficial” sun blocked is also important in comprehension and storytelling.

Research Implications

Architects in general practice have a desire to assess shading options for building design but struggle to interpret and use simulation outputs currently available.

Providing simplified models of results that lead users to concrete conclusions can increase the value of simulation for these practitioners & improve the chances they will be able to incorporate design improvements

Problem Discovery

Our team began a discovery process in early 2019. We surveyed a large cohort of English-speaking SketchUp users identifying as architects about how they use 3D drawing software to start designing buildings. There were over 310 responses, and follow-up interviews were carried out on 24 participants.

The survey results painted a mixed story - 52% of respondents stated they “use climate analysis to inform strategies” while only 24% stated they “present climate analysis findings to the client / stakeholder”, with 80% of those claiming it to be “hard / needing improvement”.

The interviews then confirmed that for most doing “climate analysis” this was essentially limited to the use of the “shadows” feature in the 3D model. In the interviews, when we asked practitioners to walk us through their design process, very few mentioned other meaningful analysis of site climate conditions. Others, using shadows mainly as their guide, were struggling with using that information to design shading or site massings.

Our conclusion: building simulation is not being meaningfully carried out during the predesign and conceptual phases of design for a large proportion of architects.

Problem Validation

After the discovery calls, we established a beta program composed of 190 practitioners, academics and internal participants, most of whom were of an architectural background in English-speaking countries. In the beta program, as well as interviews we ran surveys of participants to try to validate what we had observed in conversations. This survey had 59 responses.

Frequency of shading design

We firstly sought to validate whether participants actually need to design shading. 58 out of 59 respondents had considered using external shading on at least one of their previous 4 projects.

Tools used to design shading

We then asked what tools were used to assist with shading design. Only 29% used simulations capable of thermal analysis and these were mostly specialist architects or engineers. The most popular way to design shading was through the use of shadows or other visualisation tools.

Fig 1: methods used to design shading (out of 59)
Challenges with shading design

Most respondents cited challenges with designing shading, including time and effort generating information, and struggles converting information into design guidance. In addition, when asked about the level of anxiety associated with the results generated by their analysis, only 15% of respondents cited a high degree of confidence in their conclusions.

Solution Overview

We had observed that a reasonable number of architects cited use of sun-path diagrams as a tool for shading design. We used quiz elements in a survey to see how well architects understood sun path diagrams. 75% of respondents accurately answered most questions.

Given users were already using shadows and sun path diagrams to help with shading, we sought to enhance these workflows with a concept of “detrimental” sun, “beneficial” sun and “benign” sun as follows:

- Detrimental sun (shown as red) occurs when there is a noticeable solar intensity and the outside temperature is ABOVE the balance point temperature range.
- Beneficial sun occurring when there is a noticeable solar intensity and the outside temperature is BELOW the balance point temperature range.
- Benign sun occurring when the solar intensity is low or the outside temperature within 2°C of the balance point temperature.

The sun path diagram is divided into four patches for each hour (approximately 90 hours each) and characterised based on the most typical conditions. This helps identify how to make better use of the sun path.

External shading options could then be assessed visually by overlaying on the sun path diagram the times that at least 50% of the glazing plane is shaded.

Fig 3: sun-path diagram with coloured patches

Results

Follow-up surveys and user testing with the beta group found the following:

- The users who already understood sun path diagrams were able to more readily identify which shading solutions were suitable
- Users who previously were confused about sun path diagrams still struggled but found the star rating and bar charts a better tool for decision making and communicating design to clients.

This functionality has been released in the market as a new product accompanying the 3D design software (called PreDesign).

Next Steps

Customers are currently being surveyed when they use the feature as to whether it was used on a project and an improvement on existing processes. This information will be used to refine the thresholds used in the calculations.

An integration of this data with the shadows function in the 3D design software is also currently being researched to see if this can be a straight-forward enhancement for users whose primary workflow is using shadows to design shading.

References
