POLYTECHNIC OF TORINO
FACULTY OF ARCHITECTURE 1
Degree in Architecture
Honors theses

Performance analysis of external shading devices
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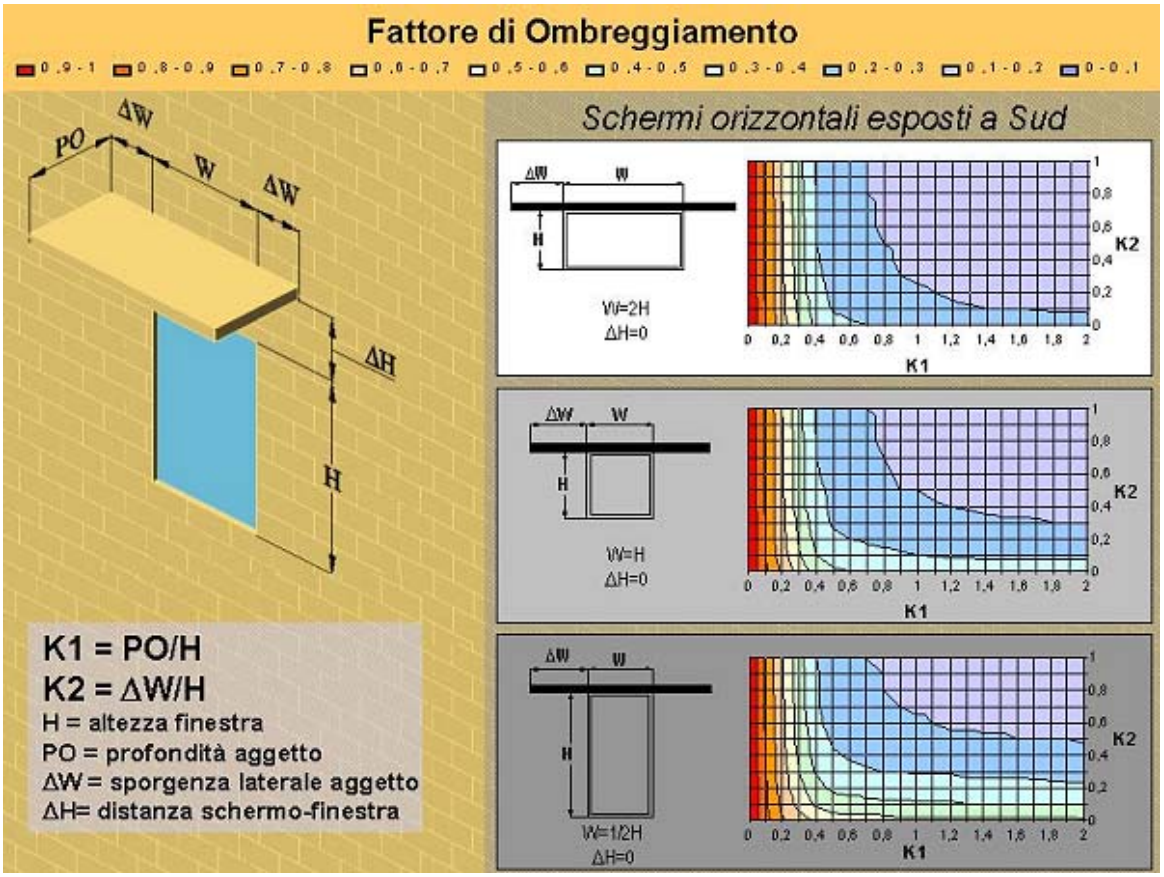
Today sustainability is a topic diffusely discussed and present in every field of human activities.
In architecture, in particular, it has brought to a new way of thinking, a new approach to design that gives more relevance to the technologies to obtain a higher quality of the built environment, reducing energy consumption and providing indoor comfort.
Shading devices have a fundamental role in this sense, since they contribute efficiently to solar radiation control, and their importance will probably increase in the next future thinking of how frequently contemporary architects use glazed surfaces to characterise their works.

In the image above, shadow has been obtained with different types of shading devices, horizontal, vertical and combined

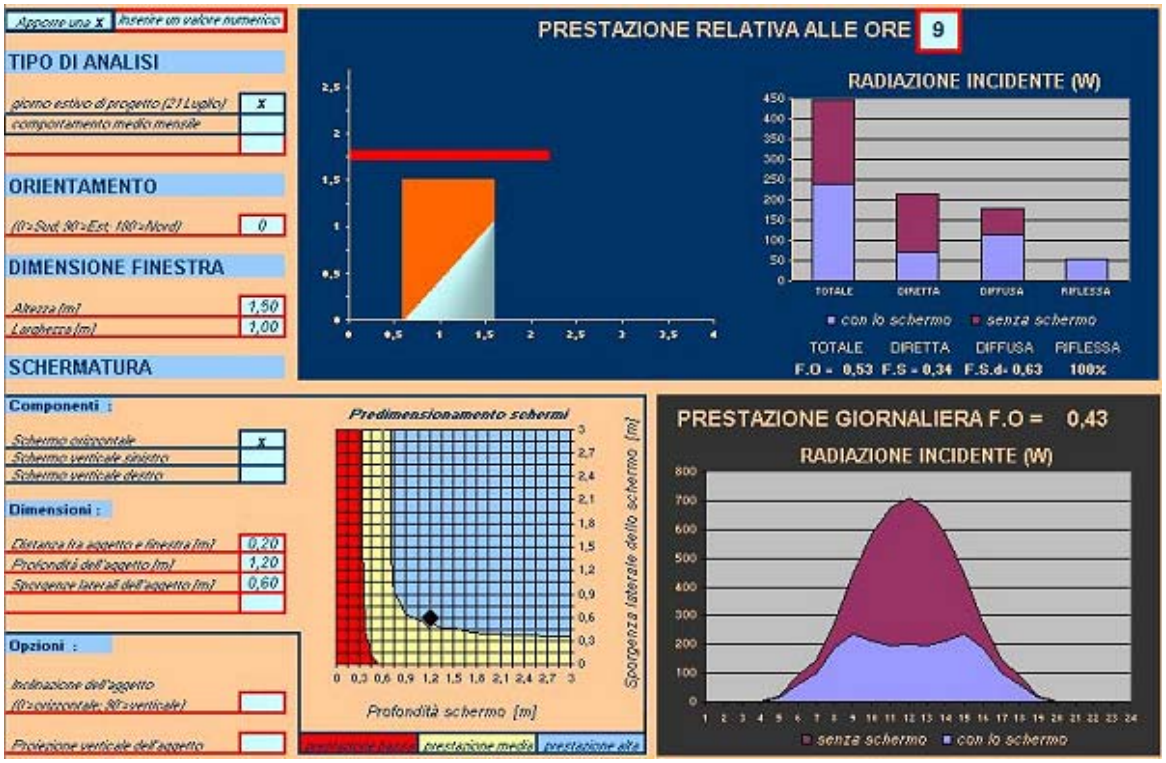
Recently, in both national and international field, many procedures have been implemented trying to provide adequate tools to characterize the performance of shading devices. These procedures, of different complexity, have been integrated on the one hand

in the technical standards concerning the evaluation of building energy performance, and, on the other hand, in specific softwares.
To understand which tools are available today for designers and their characteristics, a broad analysis has been carried out on the technical standards and on the existing softwares, generally available in internet, trying to point out their limits and potentialities.
As a whole, they have shown some limits concerning different aspects of the program, starting from the proposed interfaces, often too hard to comprehend, to the type and accuracy of the results offered. Moreover, none of them allow the users to change the program according to personal needs.
Therefore, to analyse the performance of different typology of shading devices, instead of adopting one of the existing softwares, it was preferred to create a new one based on a theoretical model developed by the Energy Department of the Polytechnic of Turin.
This program, called “Ombre” (*Shadows*), has been developed in Excel and allows to obtain, in relation to the window-overhang system defined by the user, the “Shading Factor” F.O which is the performance parameter for shading devices generally indicated in specialized literature, defined as the ratio of the global solar radiation received on the window in presence and absence of shading devices.
With the help of the program, the question of standards was then dealt with, and it showed a series of limits represented by the very simple typology of shading devices considered and the excessively simplified hypothesis to calculate the Shading Factor, that could cause errors not negligible in comparison with the more complex algorithms contained in Ombre.
But the standards have also shown some lacks concerning the methodology used for classifying the performance of shading devices. No information is given about the influences of some of the parameters defining the geometry of the window-overhang system on the final performance of the system itself, and, in some cases, the dimensions used to obtain the results offered are not even indicated.
To fill this gap and to provide for more detailed design indications a new methodology has been then developed. It has been applied to the latitude of Turin (45°) and the results have been used to create a sort of “easy to use” manual for designing external shading devices, valid only for the latitude of Turin (45°). The manual is able not only to guide designers’ choice to the most convenient typology of shading devices in different situations among horizontal, vertical and combined ones, but also to suggest proper dimensions to achieve required performance.



In the manual, the performance of each typology of shading devices considered has been valued referred to different distances H between the shading device and the window and to different ratio between the height H and the width W of the window itself (element not considered in the standard UNI 10375).
The performance of a specific window-shading system, expressed by the Shading Factor F.O, is proposed through graphics constructed in function of two adimensional paramenters indicated with K. In the case of an overhang, as the one in the figure, a system of whatever dimensions can be represented by a specific point in the graphic expressing the depth and the width of the shading device through K_1 e K_2 respectively; from the colour associated to that point it is possible to see the performance achieved

This manual is also integrated with a new version of the program Ombre, revisited and partially compiled with the inputs relative to the city of Turin, for a higher semplification in it's utilization.



Interface of the Turin model: in the column on the left the user is required to introduce all the information necessary to conduct the desired simulations (inside the blue cells). Under the title "Predimensionamento schermi"("Shading pre-dimensioning"), there's a graphic showing the performance level achievable with the specific shading device selected by the user and the dimensions necessary to obtain the desired Shading Factor. The hourly performance of the window-shading system previously defined by the user, is reported above, and consists in a graphical representation of the shadow and in a detailed analysis of the radiation received on the window, distinguishing between direct, diffuse and reflected radiation.
Finally, the global daily performance of the shading device is reported below, showing the difference between the total radiation received on the window in presence of shading device and the global solar radiation which would be received on the window without it, resumed by the Shading Factor F.O

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