SHADING MASK: A TEACHING TOOL FOR SUN SHADING DEVICES

by

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NOTE

The SHADING MASK program is a fully functional tool that calculates sun path diagrams and shading masks. It is the intent of the authors that the reader see a demonstration of the program; this paper is provided in case it is impossible to do so. This paper illustrates the major points of the program.

ABSTRACT

Sun shading devices, either as parts of a building or separately placed from a building facade, affect natural lighting and ventilation, solar gain, and overall building perfor-

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mance. The role of sun shading devices or solar radiation control systems is taught at every school of architecture. Yet, only a few architecture students, architects, and designers have applied them to reduce glare, control light intensity, radiation, and minimize cooling load on their projects.

Using a well-designed computer program to teach, and re-teach when necessary, the use of sun shading devices is more understandable, clear, and interesting than reading a book on the same topic. Having a readily available tool would also encourage architects and designers to use the shading devices as a method of conserving energy and lowering operating cost in the buildings that they design.

Visual Basic 3.0 was chosen as the development language for this Windows-based program. SHADING MASK uses Edward Mazria's rectangular sun path diagrams as a basis. The program explains basic theory of solar control; generates sun path diagrams; allows the design of overhead, side, and eggcrate shading devices; calculates solar angles and shading masks; and provides case studies of actual buildings.

2. Rectangular Sun Path Diagrams and Shading Masks
In his book Passive Solar Energy Book, Edward Mazria (1979) provided multiple sun charts based on latitudes from 28 degrees north to 56 degrees north. The chart comes in form of vertical patterns (elevations) of sun's movements. Any obstruction outside windows of a building, either trees, nearby buildings, walls, and shading devices can be added to the sun chart as shading masks (figure 2.1).

3. Computer Program

3.1. Sun Chart Diagram And Shading Mask

The most significant characteristic of the SHADING MASK program is its flexibility to plot a sun chart for any latitude, in one degree increments, for any time of the year. Users may display a specific daily sun path diagram (see figure 3.1) or annual sun path

Figure 2.1 Shading mask patterns based on Mazria's rectangular sun path diagrams
Figure 3.1 Sun path diagram for 32 degree north latitude on June 21

Figure 3.2 Annual sun path diagram for 32 degree north latitude
Figure 3.3 Shading mask for south facing window with overhang overlaid on a daily sun chart

Figure 3.4 The main screen and pull down menus
Figure 3.5 Advanced options dialogue box for specifying overhang values

Figure 3.6 Sample from theory section explaining overhang variations
Various height to depth (h/d) ratios for overhangs and width to length (w/l) ratios for fins will produce different shading mask patterns. Users can manipulate these ratios and plot 100 %, 50 %, and 0 % shading masks easily. Figure 3.3 shows one example of the shading mask overlaid on a daily sun chart.

### 3.2 Programming Structure

SHADING MASK consists of two executable programs: Shading Mask and Theory. Both of them can be run independently. The user's guide or the How To ... form gives help on how to use the program.

**Figure 3.7 Numeric table of sun path values**

**Figure 3.8 The Help menu**
The main screen (figure 3.4) has six pull-down menus: File, Shading Mask, Examples, Explain, Tables, and Help.

The File menu has options to print and exit program.

The Shading Mask menu is used to input ratios of window height to overhang depth and window width to fin length. There are both novice and advanced options (figure 3.5). The Examples menu currently contains examples of ten existing buildings that use overhangs and/or fins.

The Explain menu is intended to provide users with a general theory of shading devices and help users develop a deeper understanding of solar control devices (figure 3.6).

The sun path diagrams can also be depicted as a table of numbers. This is done through the Table menu (figure 3.7).

The Help menu functions as a user's guide. From this menu, a user can learn how to use the program independently (figure 3.8 and figure 3.9).
4. Evaluation

The intent of the program was to explain the basic theory of solar control; generate sun path diagrams; allow the design of overhead, side, and eggcrate shading devices; calculate solar angles and shading masks; and provide case studies of actual buildings. Overall, the program reaches this goal and runs well. It is very simple and easy to understand. It is also very flexible in allowing many different variables to change. Yet, still some sun charts are confusing. This problem occurs when users choose latitudes below 24 degrees (north or south) and plot annual sun charts. In these latitudes part of sun path should be plotted on a different hemisphere (see figure 4.1). Similar problems occur when users want to plot a shading mask on those sun charts.

The print command in this program is basically a built-in print method in Visual Basic 3.0. Undoubtedly, the resolution of a print out is dependent upon screen or monitor resolution. There are also many imperfect pictures in this program caused by low resolution from scanner images and other bitmap files.

The examples section of the program is also not as detailed as it should be, and an
option should be added to provide Olgyay style sun diagrams. And, of course, one could add additional options to the overhang and fin design including non-symmetrical arrangements and lightshelves.

5. Conclusions

Sun shading devices are important options for designers to consider to minimize heat gain, control daylighting, and protect walls from rain. A better understanding of these devices will hopefully generate a desire to apply them on projects. SHADING MASK is a good demonstration of how to integrate theory into a teaching or simulation tool to make important solar control information easily accessible to designers, student, and architects.

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References


