Environmental Assessment Knowledge & Tools

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BASICS

LAPA MASTER DESIGN STUDIO INPUTS GOALS

-INTRODUCE ASSESSMENT KNOWLEDGE & METHODS
-DEVELOP COMPLEX TOOLS TO APPROACH SUSTAINABILITY

• CHOOSING THE APPROPRIATE TOOLS

Architects & environmental designers have to quickly identify likely candidates tools, the following main features should be considered:

-General modelling capacities
-Zone loads
-Envelope & Daylighting
-Ventilation, Infiltration & Multizone airflow
-Renewable energy systems
-Electrical systems & equipments
-HVAC systems & equipments including CO2 control
-Environmental emissions
-Economic evaluation
-Climate data availability
-Results reporting-performance indicators
-Validation & Comparison to existing standards
-User interface & Links to other tools

Reference: 2005 USA joint report « Contrasting the capacities of building energy performance simulation programs »

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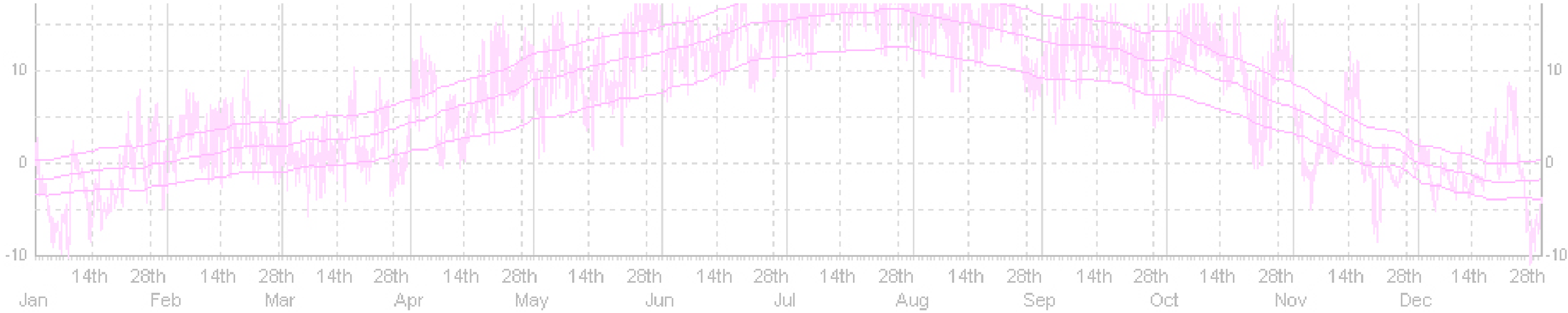
BASICS

Notions:
- BIM: Building Information Modelling
- Albedo
- Weather file formats: .epw

Current major environmental design tools:
- Autodesk Ecotect Analysis
- IDA ICE
- ESP-r
- IES
- EnergyPlus
- TRNSYS

- but also Weather Data providers



// ecotect

is an industry leading building analysis program that allows designers to work in 3D and apply tools neccesary for understanding the energy use and impact that a building will have.

Ecotect has its own, although primitive 3d modelling environment for setting up models. Alternatively, a model can be imported as a mesh from somewhere else. Once in the program, the user can run various analysis routines on it, such as thermal performance, visibility analysis.. etc.

Weather data files accompany the model data files so that the project is analysis is site specific. Some places have less data than others, although this is steadily improving. Ecotect was written by Dr Andrew Marsh.

- ARCHITECTURAL DESIGN BASED ON CLIMATIC DATA

Important notions:
Macro Climate, Mezzo Climate, Micro Climate, Sun, Wind, Climate Region

One of the main principles of architecture: establish artificial environments
→→ Design buildings that provide climatic comfort

Application of climate data on building design:
→→ Location
→→ Orientation
→→ Shape
→→ Dimension
→→ Texture & Materials
→→ Distance to other buildings

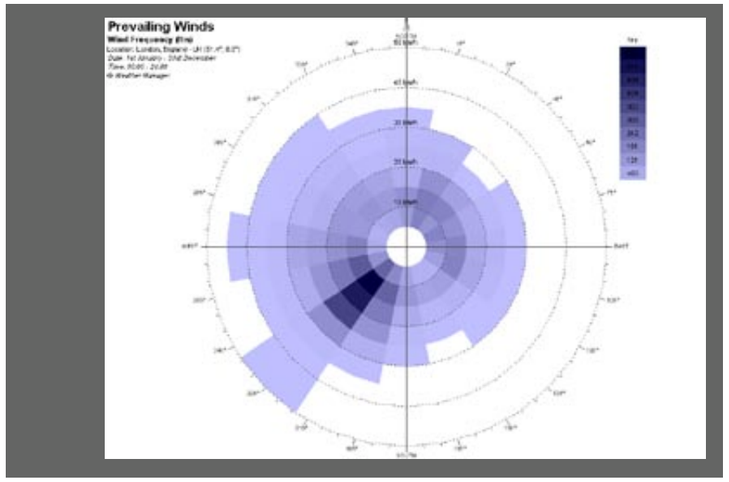
- DIFFERENT WEATHER FILES

* **TXT -** this text file contains information regarding the copyright and license agreement for use of the weather data.

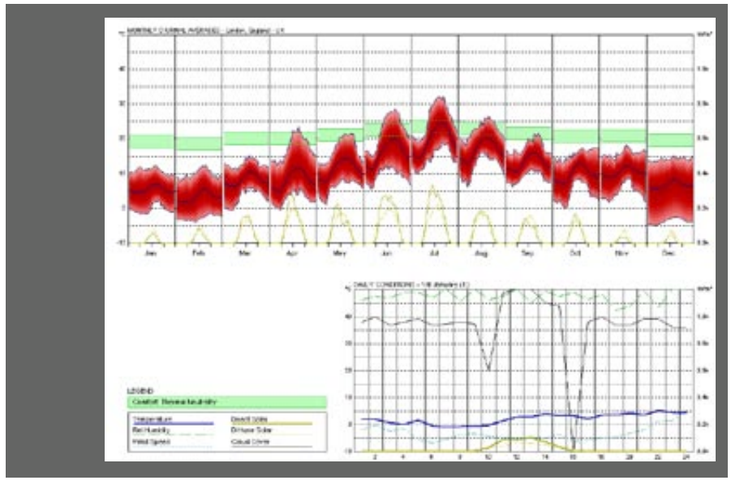
* **DDY -** this file is used by EnergyPlus to determine the degree design days for the supplied weather data.

* **EPW -** this file contains the weather data as used by EnergyPlus, and is the file we require.

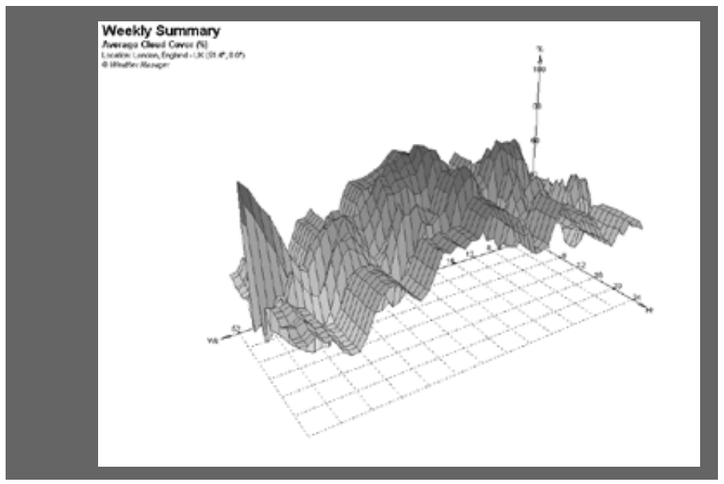
* **STAT -** this is a summary of monthly and average statistics for the supplied weather data.



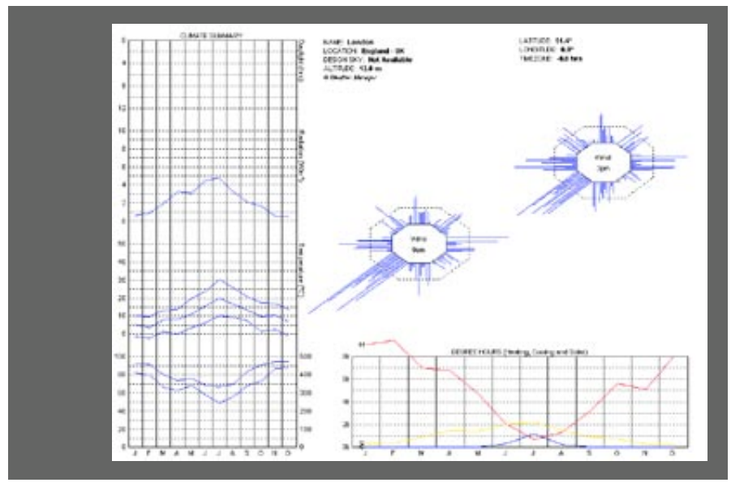
wind data



hourly data



weekly data (cloud cover show)



monthly data (cloud cover show)

weather manager

// weather data

Site specific weather data is stored in a .wea file, and can be viewed and editted using the weather manager program that runs separatelt to ecotect. The weather data files contain very detailed information about global sites, although the number of locations is limited at this time.

Data includes wind speed, humidity, dry & wet bulb temperatures, average rainfall, etc. These can be viewed at various timescales as shown above.

ORIENTATION OPTIMIZATION

BAHRAIN & ITS CLIMATE DATA

...

- BAHRAIN CLIMATE DATA

-Sun & Temperature
-Pressure & Winds
-Precipitation &Humidity
...

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ECOTECT v5.6

Software history & brief description

- Developed by Australian architect Andrew Marsh since 1996

- Ecotect is a simplified modelling environment for analysing the environmental performance of buildings

.....AT THE CONCEPT STAGE OF BUILDING DESIGN

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ECOTECT v5.6

Tool advantages

Ecotect is designed mainly to architects although quickly gaining popularity through wider environmental design community

→→ provides useful performance feedbacks at conceptual design phases
→→ facilitates a comprehensive design approach
→→ generative design & optimization tool

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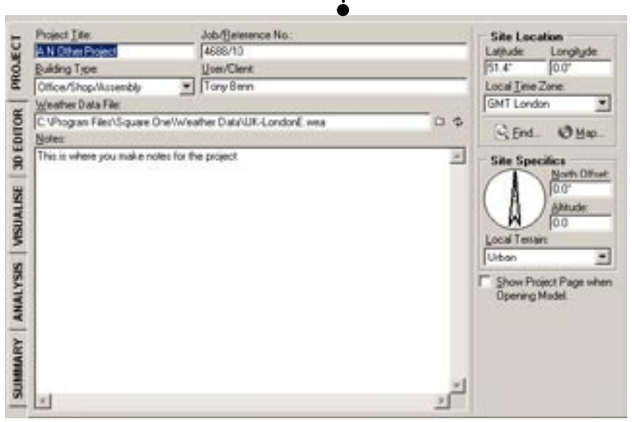
ECOTECT v5.6

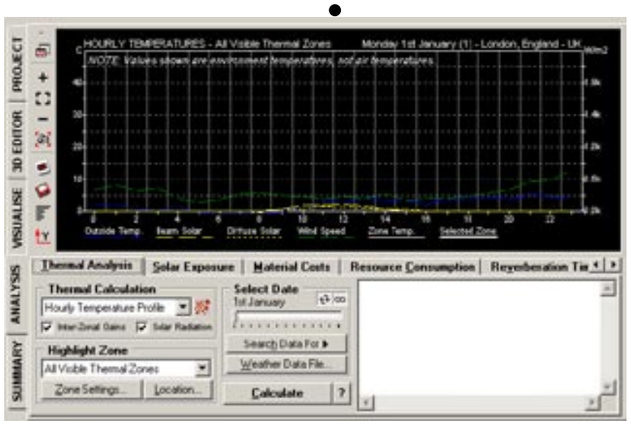
Software performances

- visual & interactive
- complete tool for building design & analysis
- 3D modeller handling complex geometry
- wide range of analysis functions:
    - thermal
    - energy
    - lighting
    - shading
    - acoustics
    - resource use
    - building cost
- results surface mapping → better understanding
- scripting engine → interactive & self-generative
- easy import/export to other engines

ecotect (main environment)

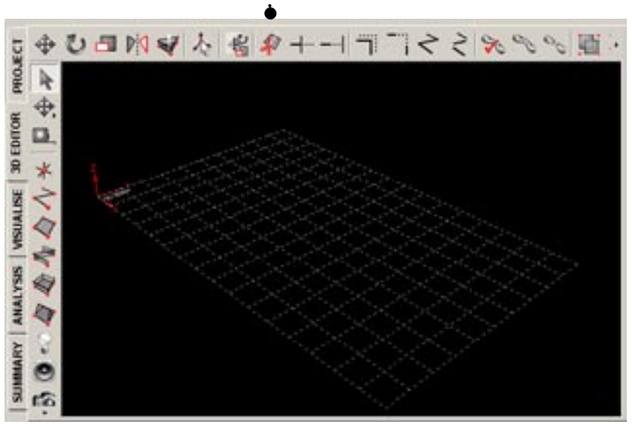


project - containing project info

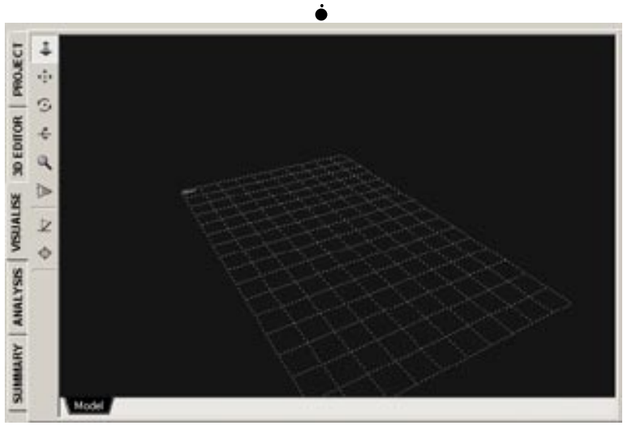


analysis - results using weather data

summary - links to ecotect community



3d editor - for simple 3d modelling



visualise - an opengl viewer

selection information

zone management

material assignments

display settings

visulisation settings

shadow settings

analysis grid

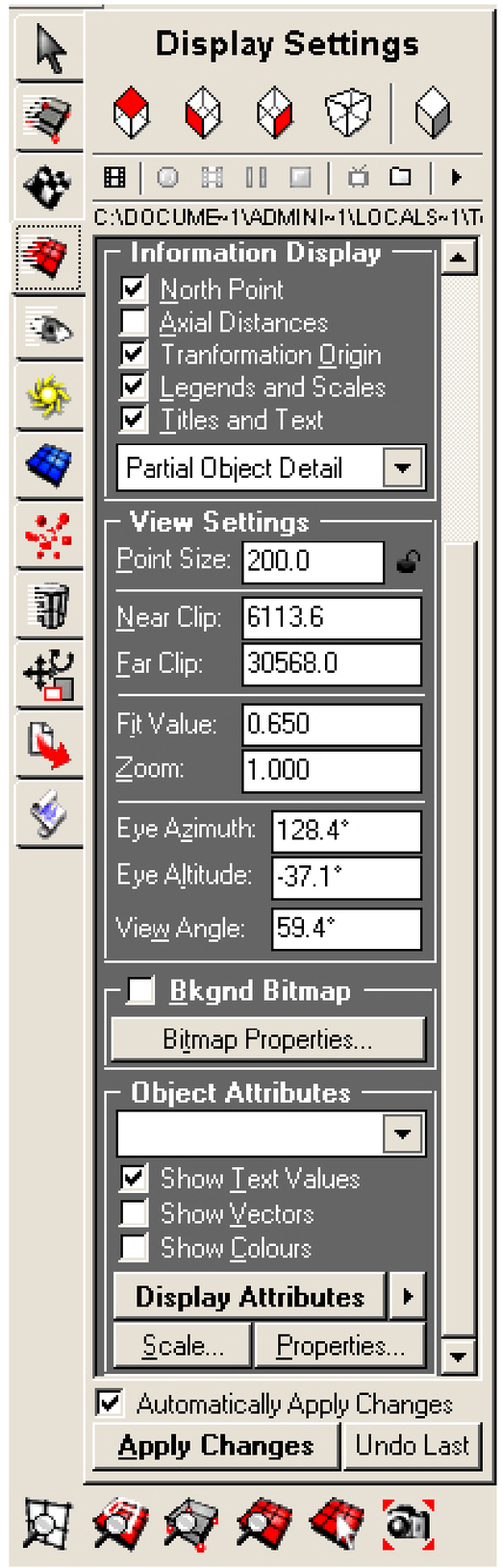
rays and particles

parametric objects

object transformation

export manager

script manager



// tools

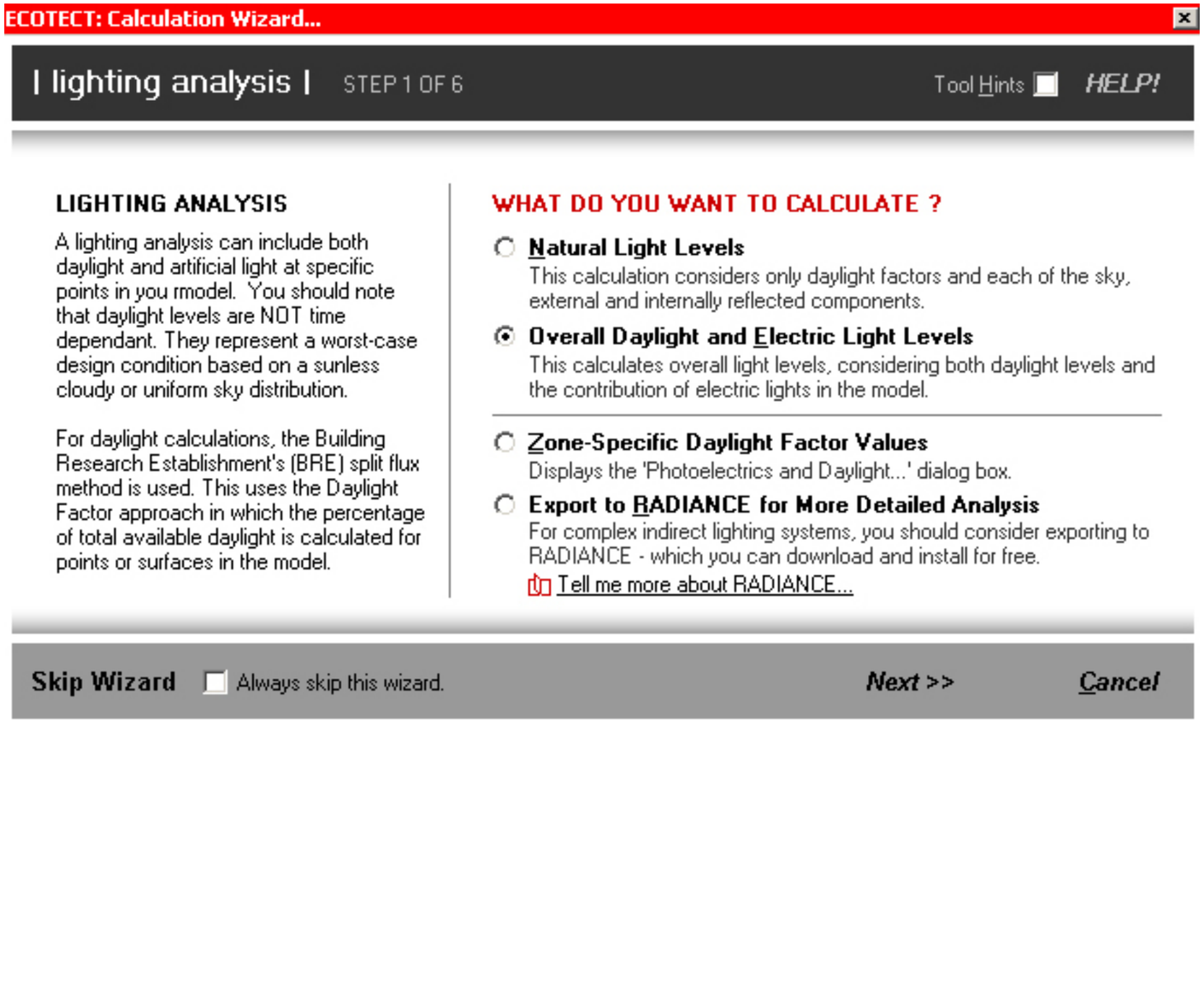
Ecotect is controlled using one main tool pallette. Layers (Zones) are maniuplated here, aswell as setting up the analysis grid, and doing the calculations.

// analysis

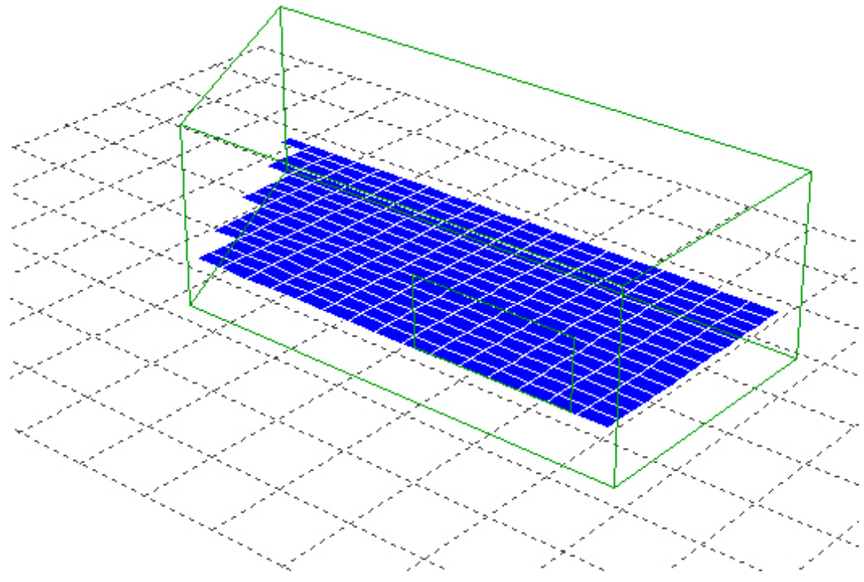
ecotect offers solar, lighting, thermal & acoustic analysis, although the latter was not explored at the workshops.

Solar analysis is used for both shadow casting and for looking at Solar exposure, including Daylight factors. Lighting analysis can include artificial light, and can be visualised using the Radiance Plugin.

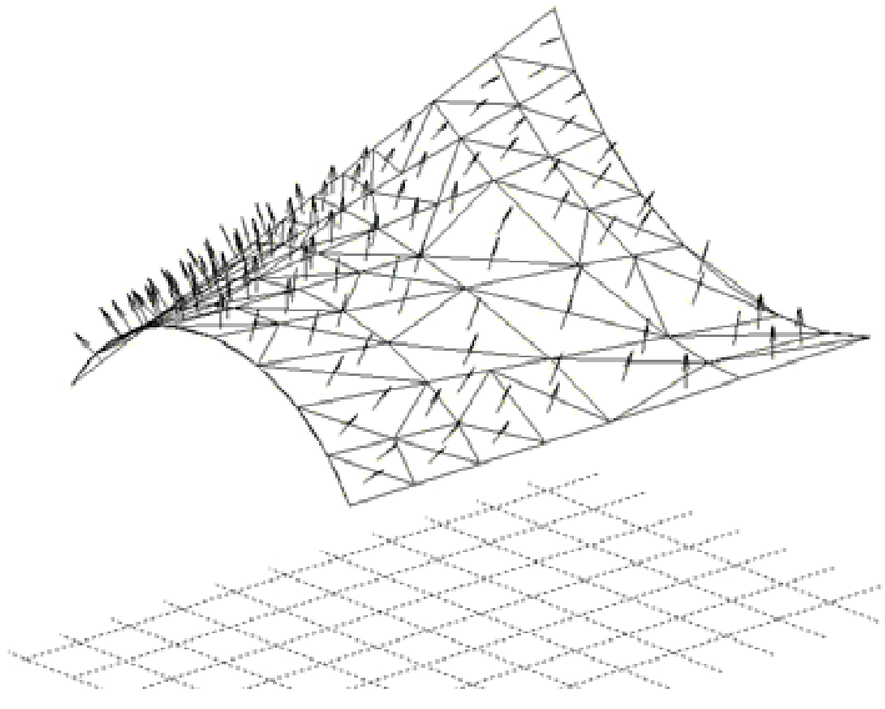
Thermal analysis can look into whether thermal comfort is achieved for certain tasks for example. Reverberation times can be sought in the acoustic analysis.

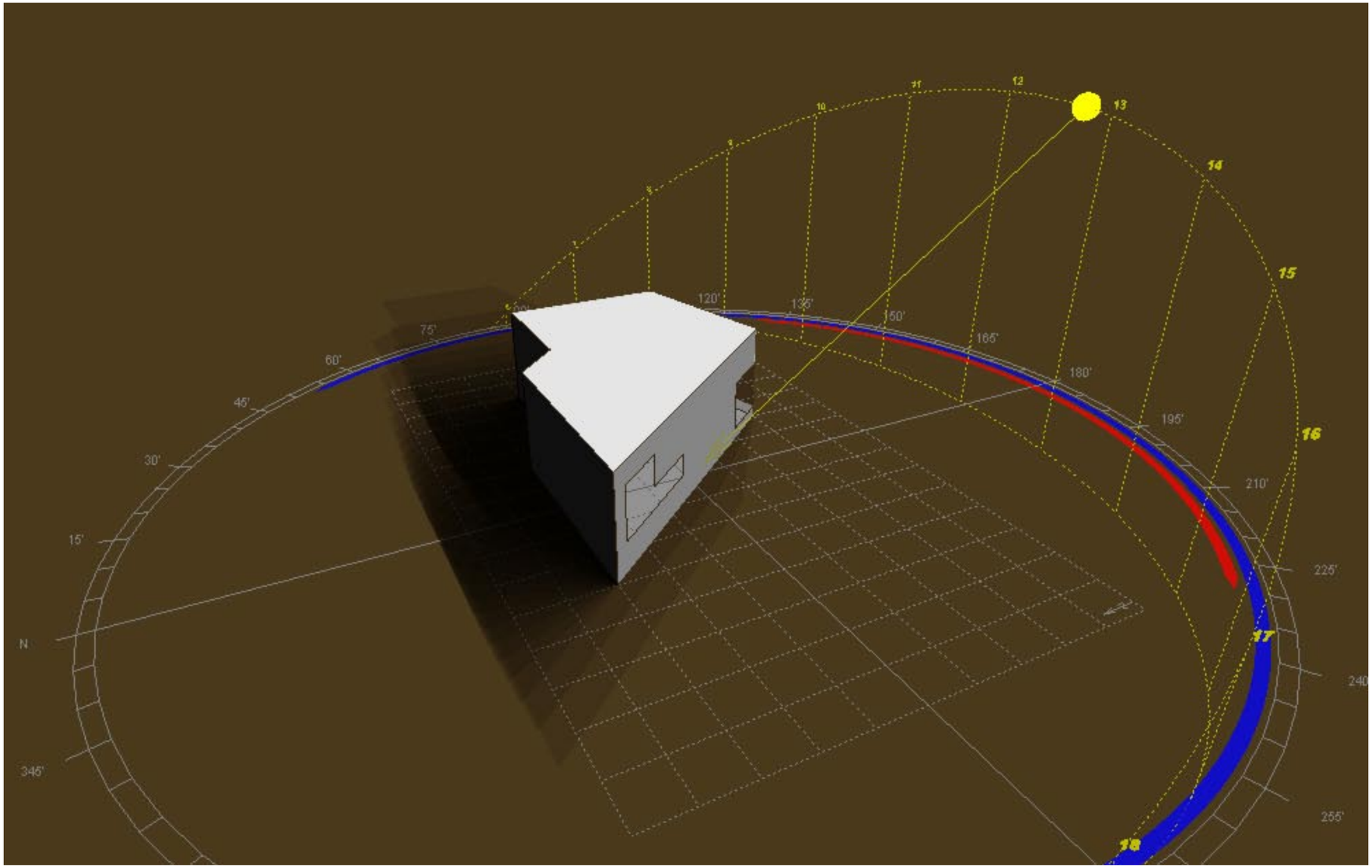


calculation requires a discrete grid, either by using the analysis grid, or by tiling an existing surface.

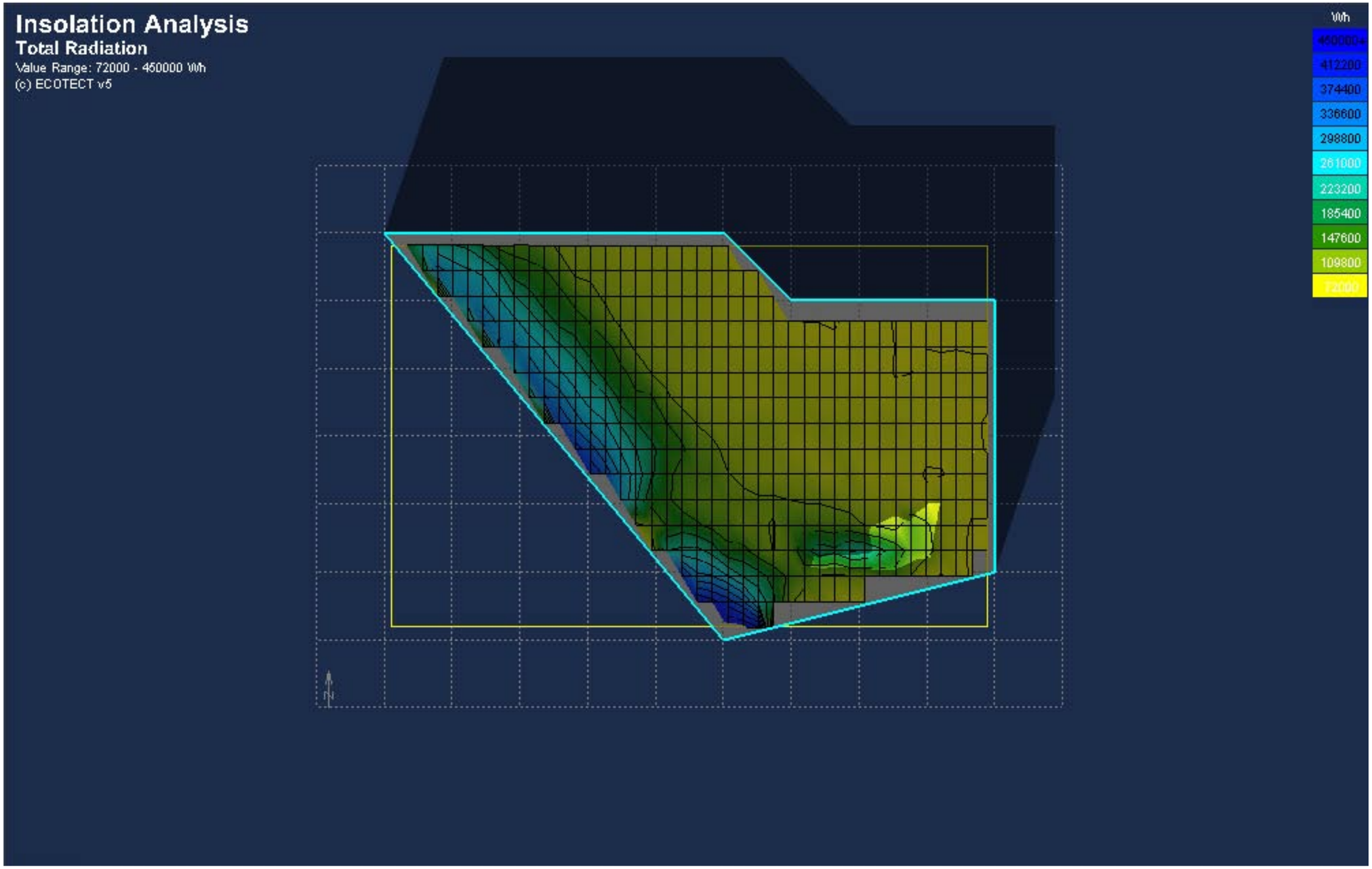


importing models (such as dxf files) can be tricky, as all normals must be aligned correctly.

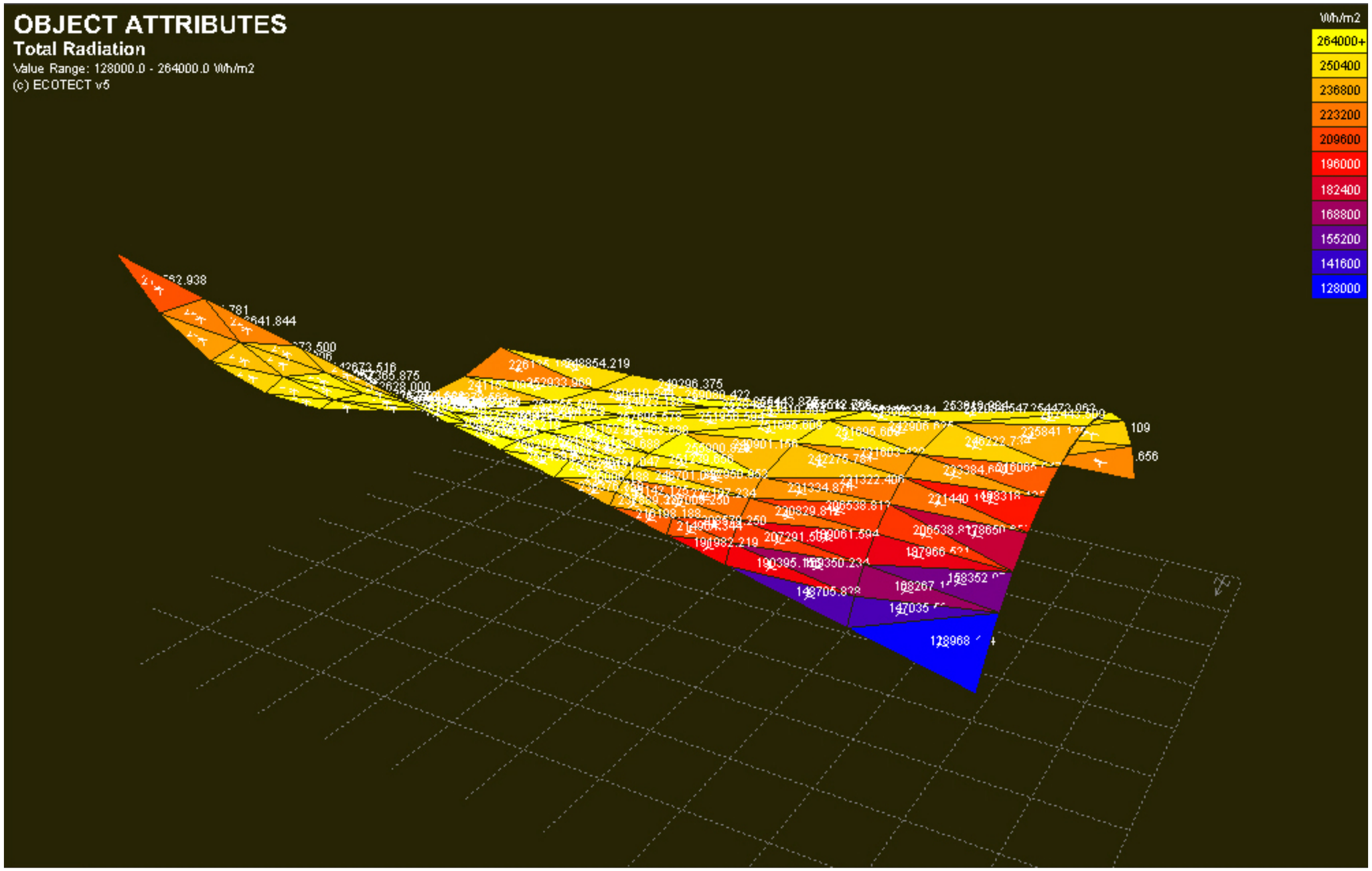




a typical sun path analysis, showing the summation of shadows throughout the day.



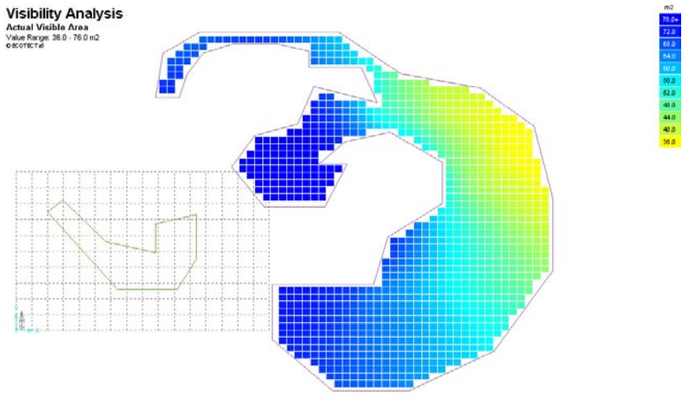
thermal radiation analysis using a grid....

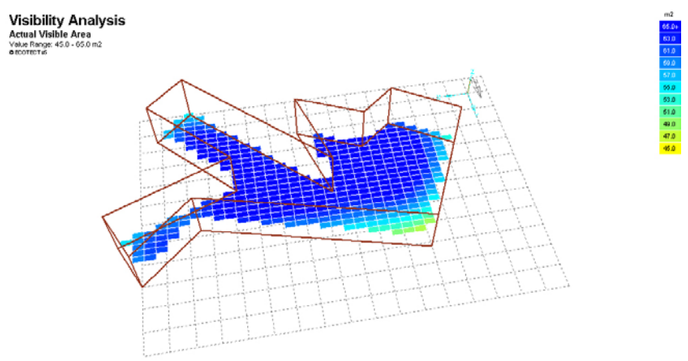


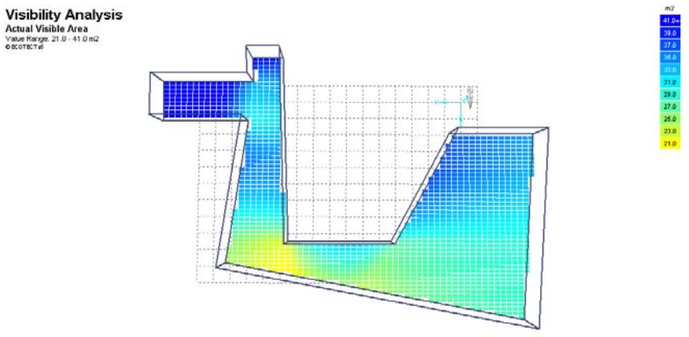
Using an imported surface canopy after checking the normals.
Quantitative data can be displayed adjacent to each mesh face.

// visibility

The overall visibility of areas (in this case plans) can be analysed and simple isovist solutions found. Some examples are shown below:



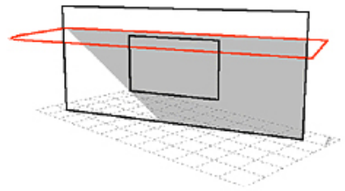




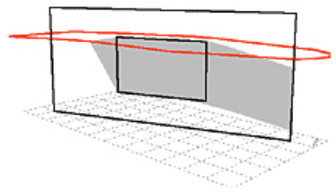
// optimisation

Along with writing your own optimisiation scripts, ecotect has an inbuilt solver for making a shading device that will forfill certain criteria.

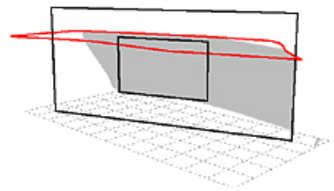
There are several ways you can make your solar shades, each described above. (taken from Ecotect Help Files).



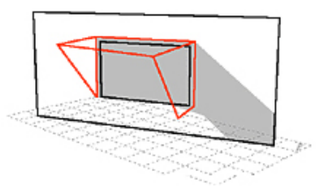
1. Rectangular Shade
A rectangular shade is generated at the specified angle.



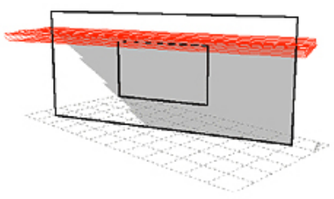
2. Optimised Shade (On)
The shape of the shade is determined by the path of the sun on the selected day. Thus the trace occurs only for the two extreme dates actually selected (perfromed only once as the position of the Sun is pretty well symetrical around June 21st).



3. Optimised Shade (Until)
The shape of the shade is determined by the path of the Sun from the Summer equinox up until the two selected dates. Thus, the shape will perfectly shade for the selected time at all dates in this range.



4. Surrounding Shade
This shade consists of an angled horizontal element as well as two vertical elements at each side of the window. Again, the shape of the shade is determined by the path of the Sun from the Summer equinox up until the two selected dates. Thus, the shape will perfectly shade for the selected time at all dates in this range.



5. Solar Pergola
This type of shade comprises a number of individual shading fins, angles so as to allow maximum winter sun penetration at noon whilst fully shading the window from the Summer equinox up to the date selected.

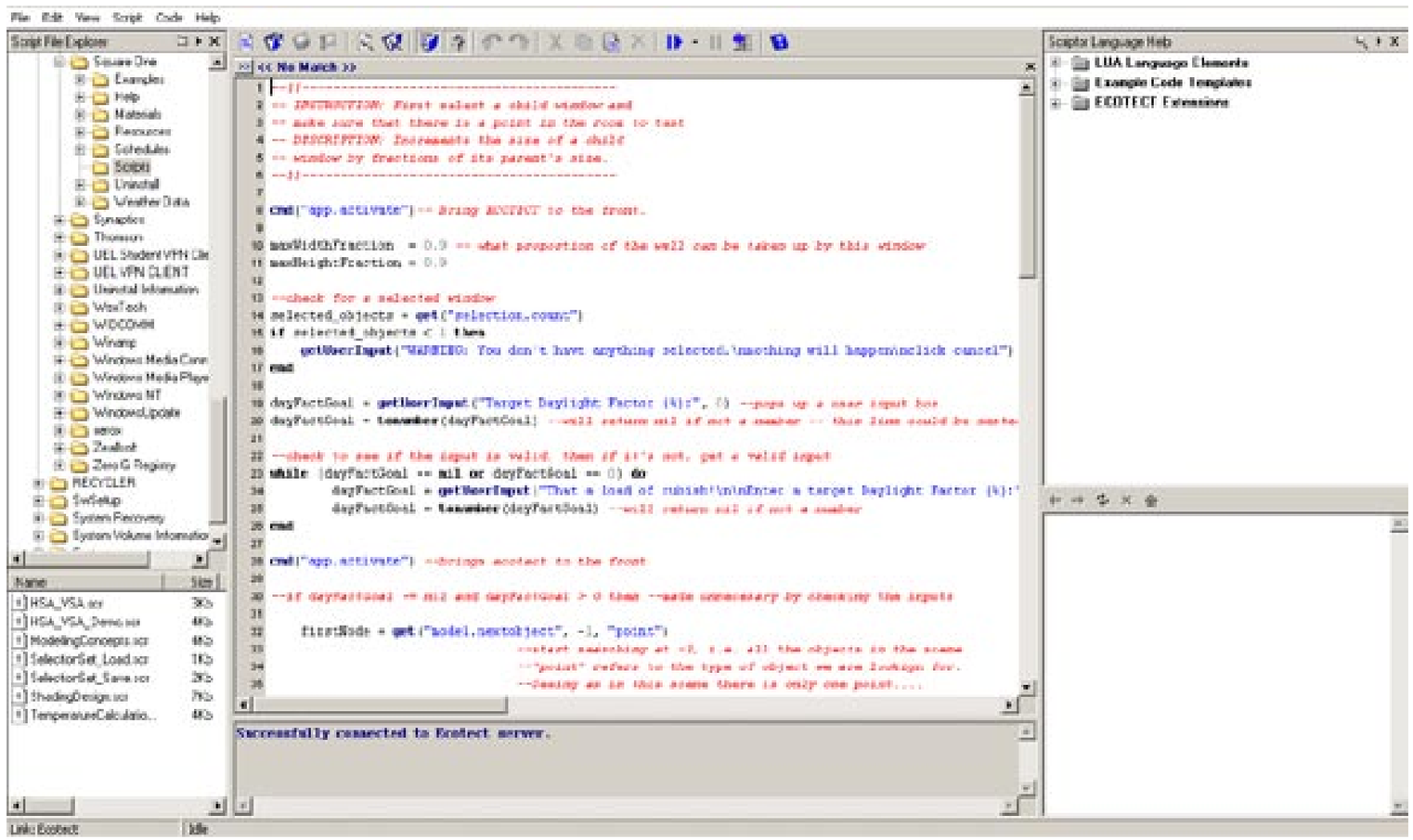
// scripting

scripting in ecotect is based on LUA, an object orientated language developed for application use.

In the workshop we went through a simple script that took a window opening, had a look at the daylight factor inside the room, and tweaked the windows size accordingly like a hill climbing algorithm.

Ecotect has its own scripting GUI that is pretty easy to use. Calculation is accessed simply by using methods and properties of the 'calc' class.

```
--[[-----------------------------------------
-- INSTRUCTION: First select a child window.
-- DESCRIPTION: Increments the size of a child
-- window by fractions of its parent's size.
--]]-----------------------------------------

-- Bring ECOTECT to the front.
cmd("app.activate")

maxWidthFraction = 0.9
maxHeightFraction = 0.9

dayFactGoal = getUserInput("Target Daylight Factor (%):", 0)
dayFactGoal = tonumber(dayFactGoal)

if dayFactGoal ~= nil and dayFactGoal > 0 then

        firstNode = get("model.nextobject", -1, "point")
        selectionCount = get("selection.count")
        selectedObject = -1
        dayFact = 0

        for i = 1,selectionCount do

                -- Get next selected object.
                selectedObject = get("selection.next",
selectedObject)
                objType = get("object.type",
```



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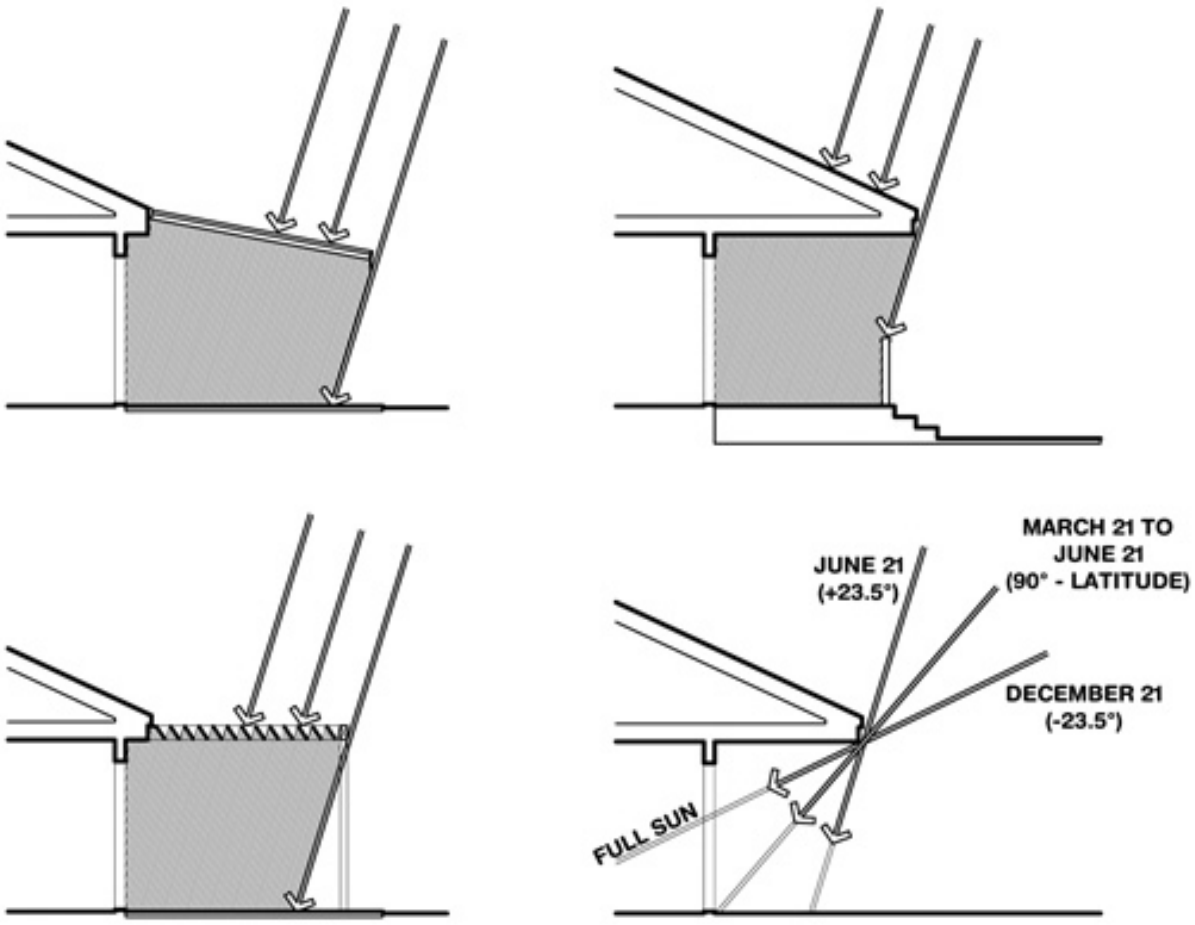
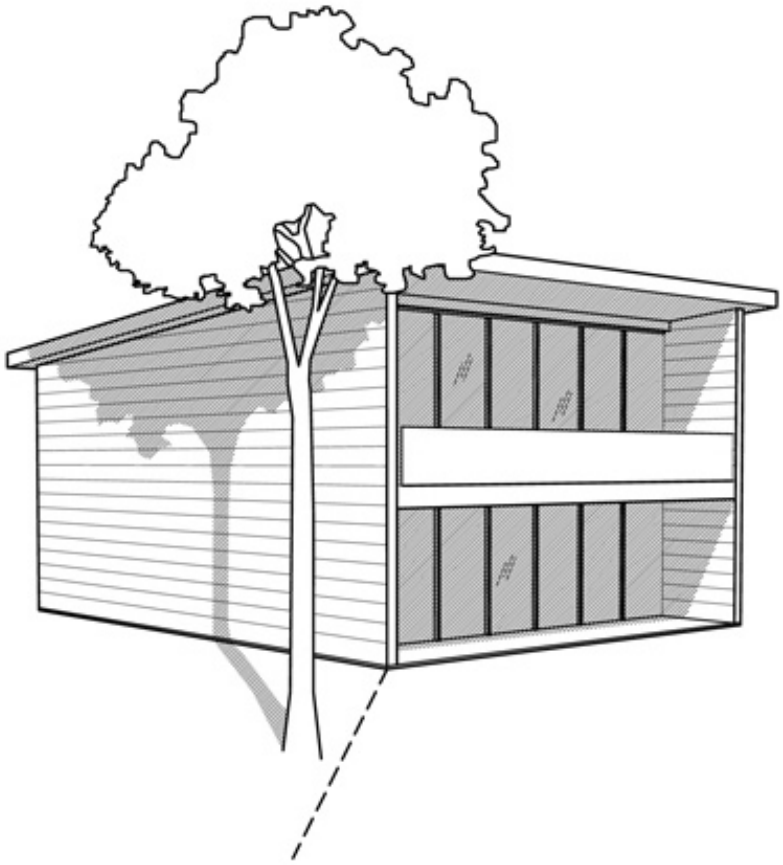
STRATEGIES

Building design guidelines in Bahrain

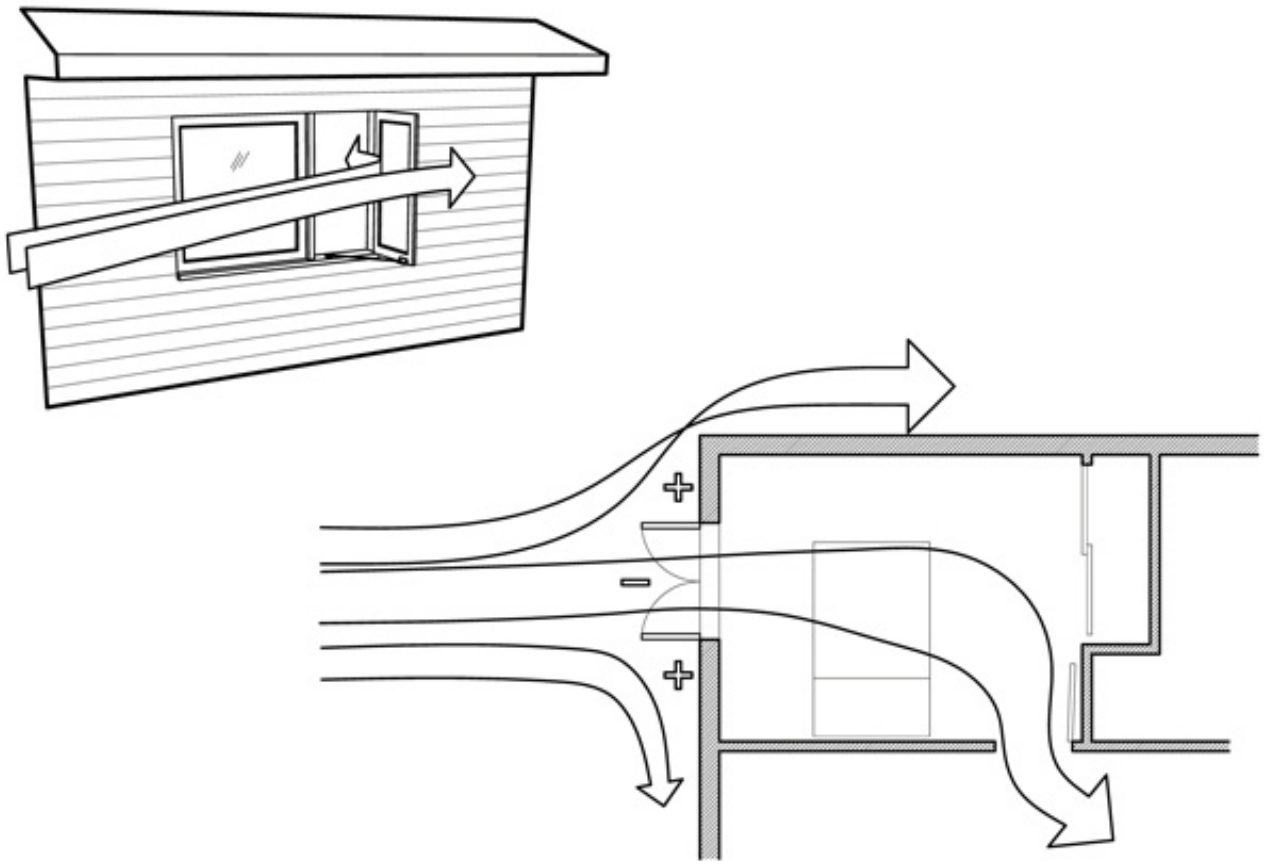
-Compact urban patterns
-Daylight & shading systems
-Natural ventilation & whole house cross ventilation
-...



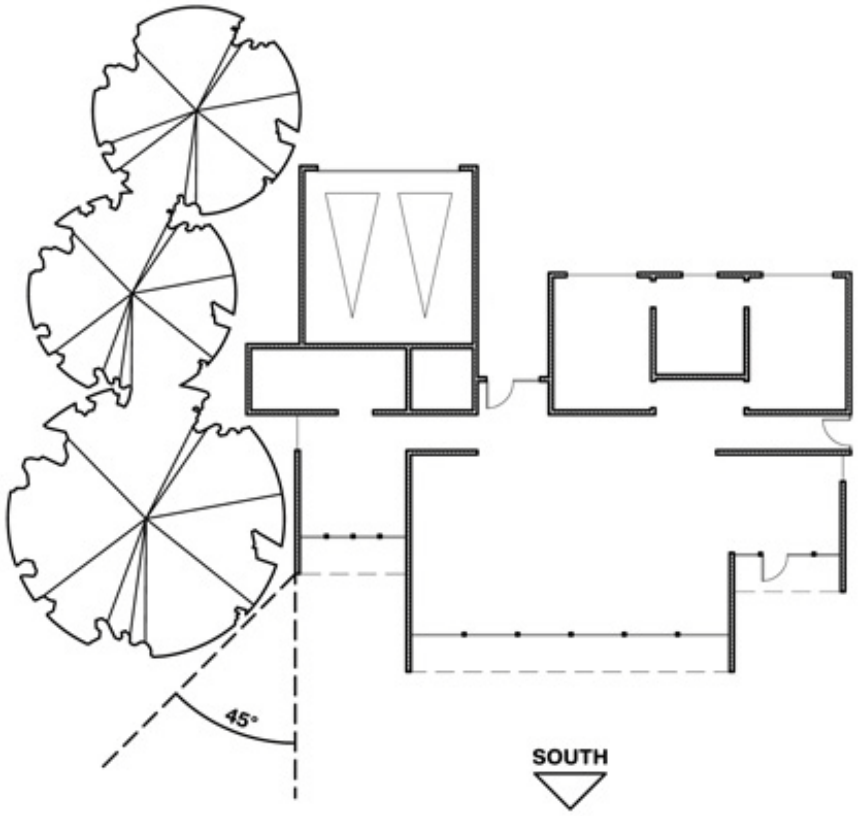
Window overhangs (designed for this latitude) or operable sunshades (extend in summer, retract in winter) can reduce or eliminate air conditioning



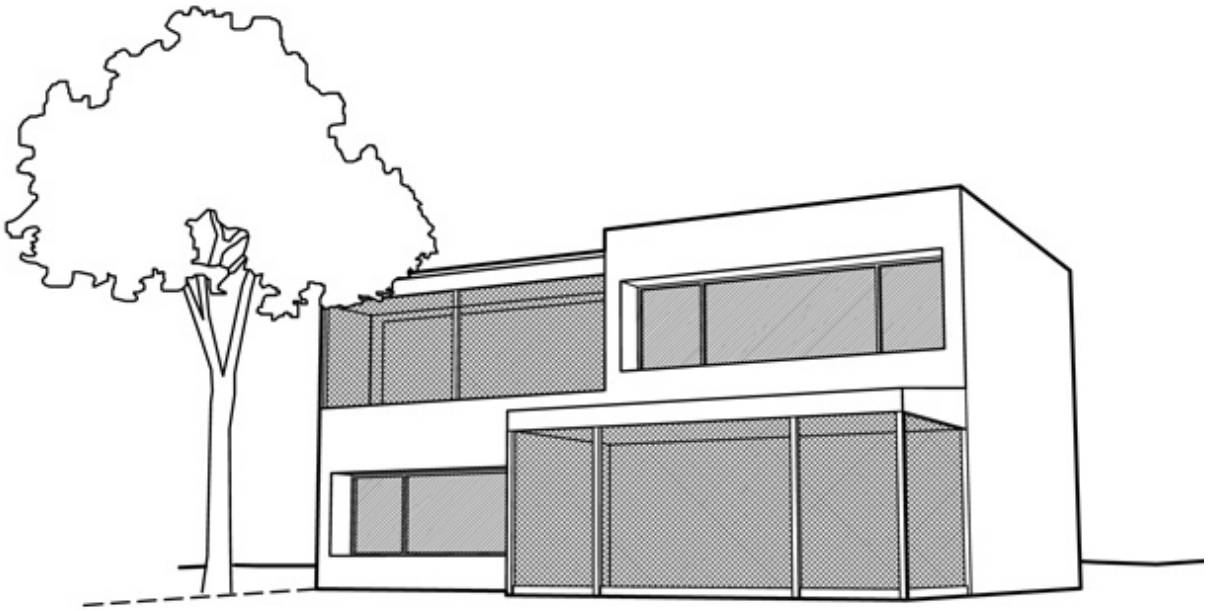
Minimize or eliminate west facing glazing to reduce summer and fall afternoon heat gain



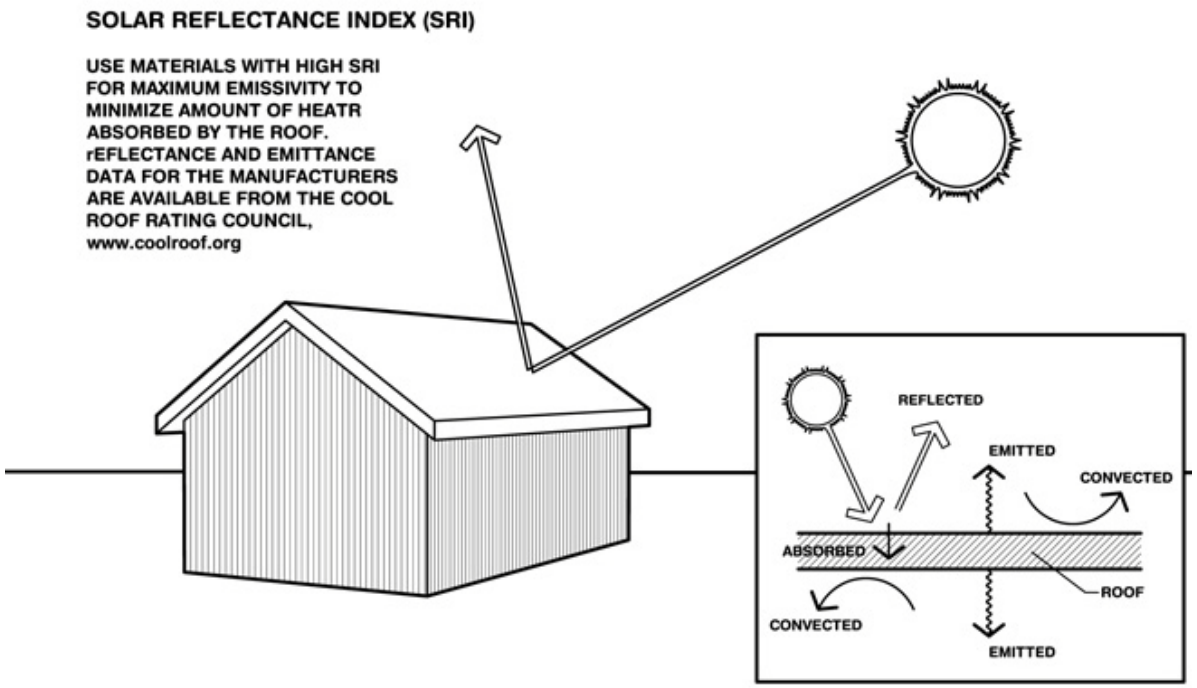
Good natural ventilation can reduce or eliminate air conditioning in warm weather, if windows are well shaded and oriented to prevailing breezes



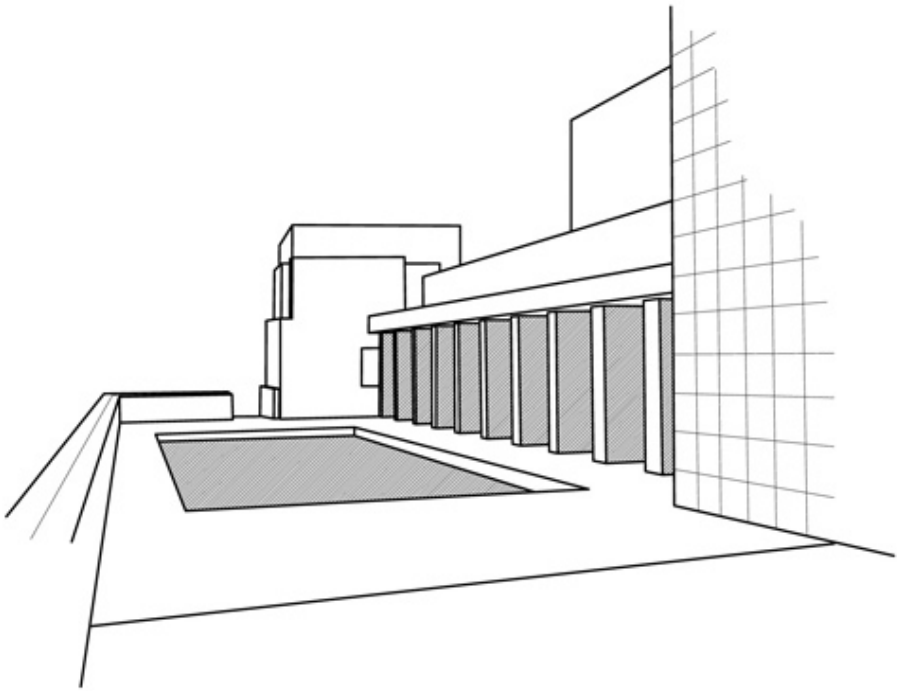
Use plant materials (ivy, bushes, trees) especially on the west to shade the structure (if summer rains support native plant growth)



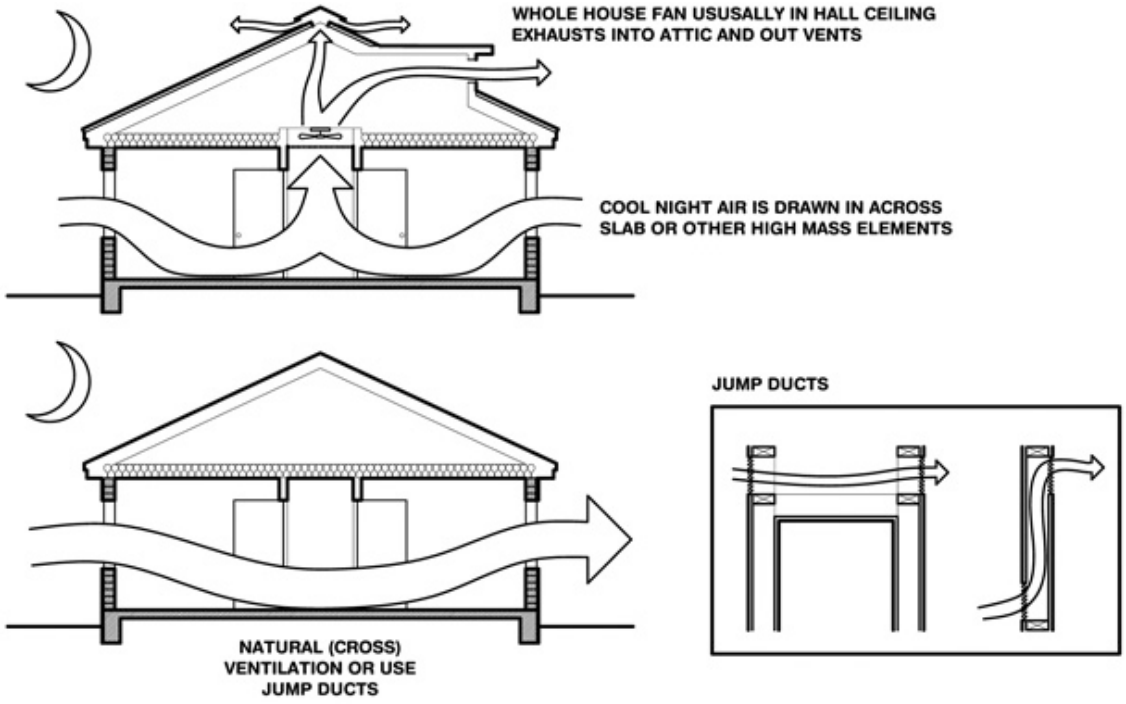
Screened porches and patios can provide comfort cooling by ventilation and prevent insect problems



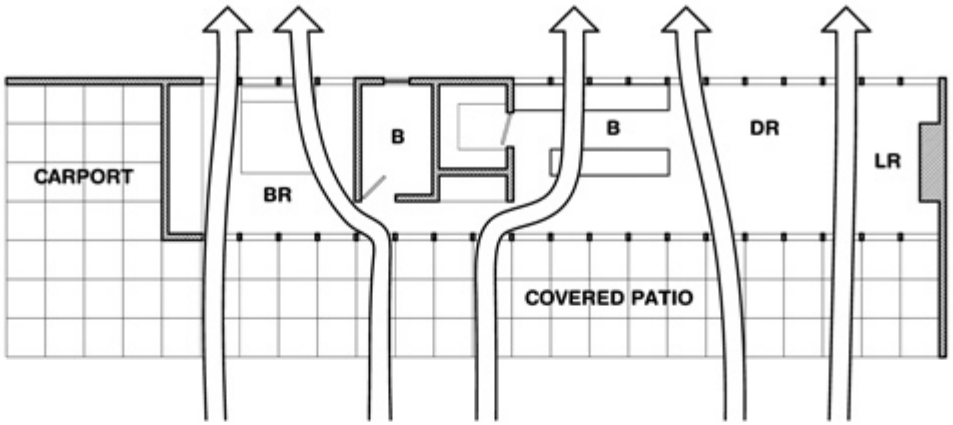
Use light colored building materials and cool roofs (with high emissivity) to minimize conducted heat gain

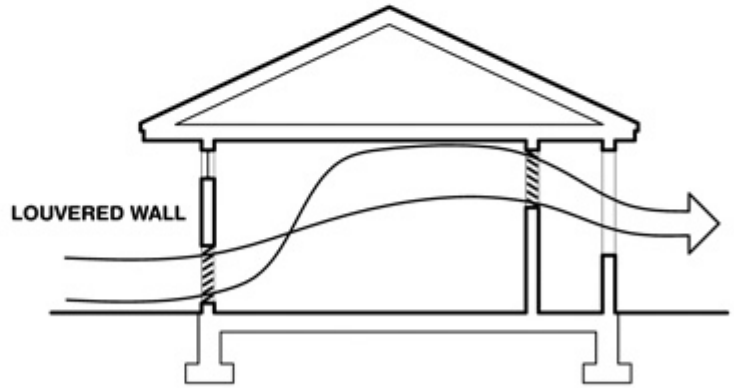


Orient most of the glass to the north, shaded by vertical fins, in very hot climates, if there are essentially no passive solar needs



A whole-house fan or natural ventilation can store nighttime 'coolth' in high mass interior surfaces, thus reducing or elimnating air conditioning





Use open plan interiors to promote natural cross ventilation, or use louvered doors, or instead use jump ducts if privacy is required

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PROJECTS

THE AGS
The Alliance for Global Sustainability

How to implement sustainable principles in developing countries:

A study of passive design & energy efficiency assessment on the project of a children's day care & medical center in Ouagadougou, Burkina Faso

CONCLUSION

IT IS NECESSARY TO DEVELOP:

- COMPREHENSIVE AND SENSITIVE ENVIRONMENTAL APPROACH
- SOCIAL RESPONSIBILITY OF ARCHITECTS

THANKS