Integrated design method and simulation tools - Eco Façade

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Concept Design Tools

• Green building rating systems have been developed that go beyond the requirements of building regulations and codes
  – BREEAM in the UK
  – LEED in the USA
• Once a decision is reached to develop a building brief to achieve a certain green rating there is a need for tools to
  – Facilitate integrated design approach early in the design stage
  – Facilitate communication building building services engineers and architects
  – Help communication between clients and the design team
• Recent concept design tools go beyond energy simulation software and include general sustainable design considerations such as:
  – Specific design strategies
  – Materials selection
  – Technologies selection
  – Evaluation of total building environmental performance (including energy)
Concept Design Tools  (Gowri, ASHRAE Journal, Jan 2005, pp43)

• Knowledge based tools
  – Design manuals and information sources

• Performance evaluation tools
  – life-cycle impact assessment,
  – new technology assessment
  – analysis and calculation of energy consumption
  – lighting
  – indoor environmental quality

• Green building rating tools
  – performance requirements
Eco-Façade
Syreeta Robinson-Gayle, EngD research engineer
Stephen Tanno and Andrew Cripps, Buro Happold Consulting Engineers

Building Research and Information,
Methodology for tool development

• Results are extracted from built-in databases derived from advanced modelling for a specified number of cases (in the form of parametric analysis) and weather data (usually country restricted).

• Results are calculated from built-in (usually energy and thermal) simplified or fast-to-run algorithms and appropriate databases for other variables of interest such as lighting and acoustics.

• It was decided to develop Eco-Façade using the ‘database’ approach because
  – the results would be based on detailed and advanced modelling and therefore more accurate and
  – user misinterpretation of results would be more difficult as the selection of cases is restricted by the development of the tool.
Methodology for tool development

• Eco-Facade was developed by using three simulation models:

  – A dynamic thermal simulation model provided energy demand and internal thermal conditions data.

  – A steady state lighting simulation model calculated the lighting environment based on the optical properties associated with the facade. The lighting model shared a common model format with the dynamic thermal modelling tool.

  – A Life Cycle Analysis (LCA) accounting tool, calculated the impacts associated with the construction and use of the building based on information about the construction and energy use in the building over a fixed time.
**You have selected case:** High Quality Curtain Walling with no shading.

### Building / Ventilation Type
- Mechanical Ventilation
- Natural Ventilation

### Energy Practice
- Good
- Typical

### Facade Selection
- **Facade Types**
  - Curtain Walling
- **Facade Options**
  - High Quality
- **Shading Types**
  - None

### Results

<table>
<thead>
<tr>
<th></th>
<th>North</th>
<th>East</th>
<th>South</th>
<th>West</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooling Energy Load / kWh/m²</td>
<td>25.2</td>
<td>34.6</td>
<td>35.1</td>
<td>33.8</td>
</tr>
<tr>
<td>Heating Energy Load / kWh/m²</td>
<td>34.6</td>
<td>25.7</td>
<td>25.7</td>
<td>31.5</td>
</tr>
<tr>
<td>Minimum Comfort Temperature /°C</td>
<td>17.6</td>
<td>17.8</td>
<td>18.1</td>
<td>17.7</td>
</tr>
<tr>
<td>Maximum Comfort Temperature /°C</td>
<td>27.0</td>
<td>24.8</td>
<td>24.7</td>
<td>25.2</td>
</tr>
<tr>
<td>Hours below 18°C /%</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hours above 25°C /%</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Hours above 28°C /%</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Average Daylight Factor %</td>
<td>6.7</td>
<td>6.6</td>
<td>9.2</td>
<td>6.6</td>
</tr>
<tr>
<td>Embodied Energy / MJ/m²</td>
<td>1610</td>
<td>1610</td>
<td>1610</td>
<td>1610</td>
</tr>
<tr>
<td>Environmental Impact / Eco-Points</td>
<td>133</td>
<td>130</td>
<td>153</td>
<td>155</td>
</tr>
</tbody>
</table>
You have selected case: High Quality Curtain Walling with no shading.

<table>
<thead>
<tr>
<th>Selection</th>
<th>Lighting</th>
<th>Thermal Environment</th>
<th>Energy Use</th>
<th>Environmental Impact</th>
</tr>
</thead>
</table>

West March

- **Internal Temperature**
- **External Temperature**
- **Relative Humidity**

### Case Selection

- **View by Month**
  - **Select Direction**: West
  - **Select Month**: March

- **View by Season**
  - **Select Season**: Winter
You have selected case: High Quality Curtain Walling with no shading.

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</tr>
</thead>
</table>

**Summer**

![Graph of temperature and light levels for different days of the week and directions]

**Case Selection**

- **View by Month**

  - Select Direction: West
  - Select Month: March

- **View by Season**

  - Select Season: Summer
You have selected case: High Quality Curtain Walling with no shading.

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Case Selection

Select Direction

West
You have selected case: High Quality Curtain Walling with no shading.

Case Selection
- Select Direction: West
- Select Season: Winter
You have selected case: High Quality Curtain Walling with no shading.

Environmental Impact by Subsystem:

- North
- East
- South
- West

Case Selection:
- Environmental Impact by Subsystem
- Environmental Impact by Damage Category
CONCLUSIONS

• Eco-Façade is a concept design tool for choosing a façade type
  – Key results are presented as a summary (heating and cooling energy, embodied energy, internal environmental conditions, environmental impact indicators)
  – Detailed results are presented; summarised by day, month or season

• Concept design tools are very useful at the early design stage of a building to facilitate discussions between clients, designers and engineers before the building design progresses to a stage that systems and technologies cannot easily be changed.
• Technology/system focused concept design tools can facilitate informed decisions for an integrated building design approach
• These decisions would need to be verified at a later stage using appropriate detailed simulation tools.
Thank you