IFC BIM-Based Building Management Framework for Energy Efficient Building Operation

Sergio Pinheiro

School of Mechanical & Materials Engineering / UCD Energy Institute
1. Introduction
2. Key concepts
3. Methodology
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The operational phase of the building is where the excess of energy is more evident.

» Planning
» Execution
  - Design
  - Construction
  - Commissioning
» Operation
» Demolition

"It is common to find well-designed buildings operating badly due to poor management. Conversely, poorly designed buildings can be improved to a great extent through good management practices" (CIBSE Guide F, 2012).
The consequences of information loss to the construction industry are enormous.

- Planning
- Design
- Construction
- Commissioning
- Operation

Building Life-Cycle:
- (1 - 5 years)
- (20+ years)

Digital
Non-Machine
Readable
Electronic Format

Loss of Value due to Handover

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Buildings do not perform as well as predicted and usually consume more energy than necessary.

Measured versus Design Energy Use Intensity (EUI)

- **Source:** Turner, C., & Frankel, M. (2008)

<table>
<thead>
<tr>
<th>Reference</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norford et al. (1994)</td>
<td>Energy consumption 2.5 times higher than predicted</td>
</tr>
<tr>
<td>Bordass et al. (2001)</td>
<td>Energy consumption twice as much as predicted</td>
</tr>
<tr>
<td>Torcellini et al. (2004)</td>
<td>Studied 6 sustainable buildings and all performed worse than predicted</td>
</tr>
<tr>
<td>Bordass et al. (2004)</td>
<td>Performance gap arises because of assumptions are not well informed</td>
</tr>
<tr>
<td>Diamond et al. (2006)</td>
<td>Average energy consumption deviates 46% from simulations</td>
</tr>
<tr>
<td>Newsham et al. (2009)</td>
<td>Compared 100 LEED buildings and found out that 35% are performing worse than their counterpart</td>
</tr>
<tr>
<td>Carbon Trust (2012)</td>
<td>Energy consumption can be as much as 5 times higher than predicted</td>
</tr>
<tr>
<td>De Wilde (2014)</td>
<td>Identified the performance gap as a function of time and external conditions</td>
</tr>
</tbody>
</table>
Science Definition of BIM

» As a noun: Building Information Model
– An instance of a populated data model of buildings that contains multi-disciplinary data specific to a particular building which they describe unambiguously

» As a verb: Building Information Modelling
– The act/process of creating a Building Information Model (BIM – a noun)

IFC is a data schema for sharing building information between different disciplines in the AEC/FM industry.

IFC is about exchanging data – it is not an application format.

The importance of IFC:
- Open
- Neutral
- Comprehensive
- Customisable
- Extensible
- ISO Standard 16739
MVD acts as a filter and reduce the size of models accordingly to specific business process.

Merged Model

For delivering asset data

COBie

Cost estimation

Energy Performance Analysis

Architectural

MVD-CV

Structural

MVD-CV

Mechanical

MVD-CV

MVD-2

MVD-3
Methodology
3 stages of the IFC BIM-Based Framework

**Information Collection**
- Design Intent
- As-Built
- BMS
- CMMS
- Others
- New Building
- Existing Building
- Management Systems

**Information Representation**
- Building Information Model
- IFC MVD
- IFC Data Exchange

**Information Usage**
- Plan
- Check
- Do
- Continual Improvement

Gathering of **useful** and **valuable** information

Consolidated interface for data representation

Timely informed decision

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Organisational Hierarchy within the Building Environment

- Deal with activities that guide the organisation toward meeting objectives
- Deal with activities that add to the organisation planning and management processes
- Deal with activities such as short-term management of maintenance and repairs
Identification of Building Manager’s Business Processes

» Benchmarking
  » Targeting
  » Scheduling
  » Procurement
  » Commissioning

» Metering
  » Monitoring
  » Maintenance
  » Continuous Commissioning

» Reporting

- Energy Benchmark
- Environmental Benchmark
- Metric
- Source
- Others

- Meter Location
- Frequency of Readings
- Location Data Storage
- Calibration Date
- Others

- Report
- Guidelines
- Suggestions
Plan-Do-Check-Act cycle for effective and efficient energy performance analysis
Property Sets for Objects describes how an object occurrence can be related to a single or multiple property sets.
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**External Wall**

<table>
<thead>
<tr>
<th>Object</th>
<th>Type</th>
<th>Materials</th>
<th>Properties</th>
<th>Quantities</th>
</tr>
</thead>
<tbody>
<tr>
<td>140 Block Insulated Cavity Plastered</td>
<td>Brick [#2314]</td>
<td>103</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Air Space</td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Insulation - Plastic Hard [#2347]</td>
<td>25</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Concrete Block - Structural [#2363]</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Plaster - Gypsum [#2364]</td>
<td>12</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Pset_WallCommon

- **AcousticRating**: 25
- **ThermalTransmittance**: 1.182
- **LoadBearing**: true
- **IsExternal**: true

### User_PerformanceBenchmarking

- **Benchmarking**: Building Regulations Part L

### User_PerformanceTargeting

- **TargetingMethod**: Building Regulation Part L
- **Target**: Thermal Transmittance
- **DrivingFactor**: -
- **TargetValue**: 0.60
Conclusion & Future Work
» The widespread adoption of BIM and the use of a comprehensive digital model is a step towards the elimination of interoperability issues.

» It is of paramount importance that building managers are involved in the earlier stages of the BLC so they can request the correct information from all disciplines.

» The proposed IFC BIM-based framework contributes to the reduction of time, cost, and effort associated with gathering information from different sources.
» Completion of the MVD to include all the identified information.

» Definition of the business rules and agreements necessary to assist the implementation of import and export functions by BIM applications.

» Submission of an MVD proposal to buildingSMART for further review by the community as well as to extend the IFC scope to cover all relevant objects.
Sergio Pinheiro
sergio.pinheiro@ucdconnect.ie

Thank you