How the Code of Practice for Retrofit & other tools can help raise the standards of design professionals

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Better Than Best Practice – Skills & Knowledge to Achieve Near Zero Energy Buildings Conference & Training
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Where we need to get to

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Fighting climate change nationally - one retrofit at a time


32.5% of final saving is expected to come from the residential sector. However housing completions in 2013 were 16.6% of 2000, & 8.9% of 2006 figure, so it appears the burden of this change will need to come from the retrofit sector.

So social housing retrofit initiatives, Mrs. Johnson’s insulation works, & Mr. McCarthy’s retro-extension are a key element of policy in fighting climate change & reducing energy imports.

TGD L 2011 says very little about retrofit but does tighten up some values. We think it gets some things right & others very wrong.

However there is been some remarkable progress in understanding the complexities of energy efficiency.
Policy: The step-by-step approach we’ve taken towards ‘carbon neutral’

- **2002**: European Performance of Buildings Directive
- **2005**: Thermal Regulations (Technical Guidance Document L)
- **2008**: 40% reduction on 2005: new dwellings
- **2011**: 60% reduction on 2005: new dwellings
- **2013**: Re-cast EPBD comes into force
- **2014**: Code of Practice for Retrofit of Dwellings
- **2015**: 40% reduction on 2005: new non-domestic buildings
- **2016**: NZEB framework, 70% reduction for new dwellings (voluntary?)
- **2018**: NZEB, 60% reduction new public buildings
- **2020**: NZEB all new buildings
BERs nationally (2014)

### Figure 2: Domestic BERs by grade

<table>
<thead>
<tr>
<th>Energy Rating</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>10</td>
</tr>
<tr>
<td>A2</td>
<td>130</td>
</tr>
<tr>
<td>A3</td>
<td>2,332</td>
</tr>
<tr>
<td>B1</td>
<td>6,880</td>
</tr>
<tr>
<td>B2</td>
<td>15,393</td>
</tr>
<tr>
<td>B3</td>
<td>33,203</td>
</tr>
<tr>
<td>C1</td>
<td>46,087</td>
</tr>
<tr>
<td>C2</td>
<td>52,276</td>
</tr>
<tr>
<td>C3</td>
<td>54,662</td>
</tr>
<tr>
<td>D1</td>
<td>55,883</td>
</tr>
<tr>
<td>D2</td>
<td>50,061</td>
</tr>
<tr>
<td>E1</td>
<td>28,739</td>
</tr>
<tr>
<td>E2</td>
<td>22,648</td>
</tr>
<tr>
<td>F</td>
<td>22,390</td>
</tr>
<tr>
<td>G</td>
<td>30,614</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>421,608</strong></td>
</tr>
</tbody>
</table>

### Figure 3: Non-domestic BERs by grade

<table>
<thead>
<tr>
<th>Energy Rating</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>2</td>
</tr>
<tr>
<td>A2</td>
<td>28</td>
</tr>
<tr>
<td>A3</td>
<td>181</td>
</tr>
<tr>
<td>B1</td>
<td>459</td>
</tr>
<tr>
<td>B2</td>
<td>1,080</td>
</tr>
<tr>
<td>B3</td>
<td>1,747</td>
</tr>
<tr>
<td>C1</td>
<td>2,602</td>
</tr>
<tr>
<td>C2</td>
<td>2,512</td>
</tr>
<tr>
<td>C3</td>
<td>1,995</td>
</tr>
<tr>
<td>D1</td>
<td>2,271</td>
</tr>
<tr>
<td>D2</td>
<td>1,694</td>
</tr>
<tr>
<td>E1</td>
<td>1,054</td>
</tr>
<tr>
<td>E2</td>
<td>912</td>
</tr>
<tr>
<td>F</td>
<td>1,134</td>
</tr>
<tr>
<td>G</td>
<td>1,923</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>19,584</strong></td>
</tr>
</tbody>
</table>
‘Culture eats policy for breakfast’

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A building culture that does not like to measure, record or discuss failures

For most of the construction industry, building performance in use is another planet ...

“in theory, theory and practice are the same,
in practice they aren’t.”
SANTA FE INSTITUTE

“designers seldom get feedback, and only notice problems when asked to investigate a failure.”
ALASTAIR BLYTH
CRISP Commission 00/02

“I’ve seen many low-carbon designs, but hardly any low-carbon buildings” ANDY SHEPPARD Arup, 2009

Stamford Brook in the UK is an estate of about 700 dwellings designed in 2002 and finished in 2007.

It was designed to a standard ~15% above the UK Part L(2006)

The performance gap at Stamford Brook was equivalent to dropping two standards, so did another timber frame project studied.
### What happens when we measure how we actually build?

<table>
<thead>
<tr>
<th>Detail</th>
<th>Design Value</th>
<th>Observations from site</th>
<th>Realised Value</th>
<th>Increase in Heat Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor U-value</td>
<td>0.20 (W/m²K)</td>
<td>Floor construction completed prior to research team involvement</td>
<td>0.20 (W/m²K)</td>
<td>0.0</td>
</tr>
<tr>
<td>Wall U-value</td>
<td>0.18 (W/m²K)</td>
<td>![Wall U-value images]</td>
<td>0.30 (W/m²K)</td>
<td>+3.8 (W/K)</td>
</tr>
<tr>
<td>Roof U-value</td>
<td>0.13 (W/m²K)</td>
<td>Increased timber fraction</td>
<td>0.15 (W/m²K)</td>
<td>+1.5 (W/K)</td>
</tr>
<tr>
<td>Window U-value</td>
<td>1.50 (W/m²K)</td>
<td>Original design had a &quot;whole window&quot; U-value of 1.5 W/m²K. The installed windows had a &quot;centre-pane&quot; U-value of 1.5, a whole window value of 2.0.</td>
<td>2.00 (W/m²K)</td>
<td>+9.1 (W/K)</td>
</tr>
</tbody>
</table>
What happens when we measure how we actually build?

<table>
<thead>
<tr>
<th>Party Wall U-value</th>
<th>0.40 (W/m²K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal Bridging y-value</td>
<td>0.40 (W/K)</td>
</tr>
<tr>
<td>Total Fabric Heat Loss</td>
<td>64.9 (W/K)</td>
</tr>
</tbody>
</table>

Experimental measurements taken revealed a thermal bypass in operation at the party walls, resulting in them having an effective U-value of 0.40 W/m²K. This & other examples prove we need to put at least as much effort into funding research into under-performance, changing culture, and measuring performance during and after construction, as into creating new standards, new targets... we must ensure a high percentage of buildings actually meet the standards!
An Irish example of testing guidance: how to insulate a water tank

Homebond manual (7th Ed.)

The common reality

SR 54 – Code of Practice for EE retrofit

Killarney Plastics – a simple solution
We need to change, we need to learn... continuously

‘Underperformance, currently masked by cheap energy and oversized heating systems, will become more noticeable and less acceptable as energy prices rise and target emission rates are reduced

‘The carbon emission limits of Code Level 3 and beyond are likely to entail increased complexity, less redundancy, faster rates of innovation and unfamiliar low and zero carbon technologies

‘Unless the house building industry is able to develop systems and a culture capable of managing these challenges, underperformance is likely to increase in relative and possibly even absolute terms

‘Specifically, the ability of all parts of the construction industry to learn and to retain learning will need to be transformed’
of construction professionals did not know about the nearly-zero energy requirement for all new buildings by 2020.

58% of respondents had not yet designed or built dwellings to Part L 2011.

Of that group found it a challenge, saying it was moderately difficult or very difficult to achieve compliance.

70% of those who had done recent training in energy efficiency said complying with Part L 2011 was easy,
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Training design professionals
Steps to achieving good airtightness

**Pre Construction**
- Define strategy
- Identify air barrier in all details & drawings
- Engage with drawing specs, i.e. toolbox workshop for design team & contractor

**Pre Tender & Tender**
- Specify level of performance beyond regulation minimum
- Be explicit in drawings & specs: use performance + prescriptive format
- Allow sums against ATT and also for builder to prepare site for test
Changes in window & door U-values from TGD L 2005 to 2011

Permited variation in area and average U-values of opes
(external doors, windows and rooflights)

The end of the ‘glass box era’ may be upon us

‘Glass box’ extension
ope area is 70% of floor area

PH windows
U ≤ 0.8 W/m²K

RIA

window U-values from NSAI database

default windows in DEAP U ≥ 1.7 W/m²K
(all U-values shown are whole window values)
10 comments on courses

1) Frequently told to avoid scientific basis & just cut to solutions!

2) The variance in knowledge amongst attendees is huge. Practicing PH designers and builders are clearly differentiated.

3) Frequently told that courses should be longer but architects rarely book courses longer than a day.

4) Professionals feel buffeted by constant, onerous changes in legislations and standards. Many would prefer one large change than many smaller.

5) They can feel unsupported by legislators, institutes, and educators of new graduates.

6) They complain that if they learn the builder, engineer, QS etc. aren’t.

7) All despair at dysfunctional building control system. SI.9 is a further burden.

8) They know budget or builder often hinder quality, they are less willing to see how their aesthetic and technical designs often do too.

9) Changes have happened so quickly that we can have difficulty persuading what we teach is not elective higher standard but min. compliance.

10) They all go away with a fresh understanding of what we need to learn.
Support for the Specifier & Certifier

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The need for signposts (using EN & BS standards)

Approved Doc. C - 2010
Site preparation and resistance to contaminates and moisture

BS 5250 - 2002
Code of practice for control of condensation in buildings

Annex F – adv. sim. methods

BS EN 13788 - 2002
Hygrothermal performance of building components and building elements – calc. methods

BS EN 15026 - 2007
Hygro perf. of building components — Assess. of moisture transfer by numerical simulation
The need for signposts (using EN & BS standards)

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First principles approach

‘Responsible Retrofit’ Knowledge gap survey
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Research & Desktop & Site Assessment Tools
Site risk assessment - building surveys & physical measurement

External and internal surveys

'Karsten tube' measuring for driving rain water uptake
Desktop risk assessment methods (Glaser)

Dew Point Assessment (Glaser Method)
Applicable Standard: IS EN 13788 (2012)

- Useful assessment tool
- One dimensional
- Steady state conditions
- No air movement
- Moisture in materials
- No rainwater
- Not accurate
- Advanced methods in BS EN 15026

Monthly, steady state, simplified -
Suitable only for capillary broken buildups with rainscreens where the internal moisture load is dominant and the airtightness and windtightness are good
Hourly, transient, detailed - particularly useful for risk assessing IWI for solid walls, timber frame, flat & green roofs, impact of air leaks and water penetration

It is not computational fluid dynamics, it can only use info provided
Airtightness performance depending on dwelling typology

- Air permeability $q_{50}$ (m³/m²h)
- Air change rate $n_{50}$ (ac/h)
Airtightness performance depending on dwelling typology

- Blue squares: Air permeability $q_{50}$ (m³/m²h)
- Orange squares: Air change rate $n_{50}$ (ac/h)

Semi-D

Volume/area ratio

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Airtightness performance depending on dwelling typology

- air permeability $q_{50}$ ($m^{3}/m^{2}h$)
- air change rate $n_{50}$ (ac/h)
Airtightness performance depending on dwelling typology

Detached houses
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Useful recent guidance & research

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Burgeoning guidance in EE retrofit

Aereco - Evaluation of the Impact of Retrofitting a Mid-terrace 1950’s House in Dublin on Indoor Air Quality

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2013  STBA – Responsible Retrofit
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2014  STBA – Responsible Retrofit Guidance Wheel guidance

http://responsible-retrofit.org/wheel/
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2014  STBA – Moisture Risk Assessment and Guidance, & Technical Appendix
       (http://responsible-retrofit.org/wheel/)
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(http://responsible-retrofit.org/wheel/)

2014
Historic Scotland – tech. papers incl. TP15 Assessing Insulation Retrofits...
http://www.historic-scotland.gov.uk/technicalpapers
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2015  DCC - Built to Last – Energy Efficiency in Pre-1945 Historic Dwellings in Dublin City
Thank you