OpenBuildingControl:
Performance Evaluation, Specification and Verification of Building Control Sequences

LBNL – ARUP – Integral Group – Taylor Engineering – PNNL/BIG
Michael Wetter (PI) & Philip Haves (Co-PI)
The team brings together MEP firms, facility owners & operators, control integrators, experts in specifying sequences of operations and in controls-oriented modeling.

In addition to CEC:

- Subcontractors
  - Taylor Engineering (Steve Taylor)
  - PNNL/BIG (Paul Ehrlich)
  - ARUP (Cole Roberts)
  - Integral Group (Andrea Traber)
  - Oracle (George Denise)
  - Controlcol (Brian Turner)
  - Stanford (Gerry Hamilton)
  - CBRE/ESI (Paul Oswald)
  - Controlco (Brian Turner)
  - kW Engineering (Jim Kelsey)
  - Google (Mark Hydeman)

Includes control companies

- Technical Advisory Group
  - Michael Wetter (PI)
  - Phil Haves (Co-PI)
  - LBNL staff

Cost-share partners

U.S. DEPARTMENT OF
Energy Efficiency & Renewable Energy
Controls is the Achilles heel of commercial buildings, yet there is not end-to-end quality control, and no standardization for control logic.

<table>
<thead>
<tr>
<th>Human factor</th>
<th>Not-specified</th>
<th>Operator indifference</th>
<th>Operator interference</th>
<th>Operator unawareness</th>
<th>Operator error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data management</td>
<td>12.0</td>
<td>0.0</td>
<td>10.4</td>
<td>4.2</td>
<td>6.8</td>
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<tr>
<td>Operation system</td>
<td>1.0</td>
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<td>Programming</td>
<td>31.3</td>
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<td>Input/output implementation</td>
<td>2.1</td>
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<tr>
<th>Hardware</th>
<th>Not-specified</th>
<th>Communication</th>
<th>Controlled device</th>
<th>Controller</th>
<th>Input device</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data management</td>
<td>0.3</td>
<td>1.6</td>
<td>12.0</td>
<td>2.6</td>
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End-to-end quality control

What if control sequences could be designed, improved, and deployed error-free at lower costs to the owner, designer, controls provider and commissioning agent.

Standard for control logic

BACnet standardizes communication,

OpenBuildingControl will standardize expressing control sequences and functional tests for bidding, automatic implementation and automated functional testing.

Control-related problems (Ardehali, Smith 2002)
We develop a process with an integrated set of tools that allows end-to-end quality control, reuse of best practice control sequences, and continuous verification against design intent.

Additions to OpenStudio/EnergyPlus toolchain

Workflow performance quantification and verification against design specification
Advantage, Differentiation, and Impact

Energy-efficient, correctly functioning control sequences, at lower cost to owner, designer and control provider.

Key take-away
• Contribute to closing the performance gap between design and operation through correct implementation and verification of controls.
• Provide industry and DOE’s tools program with formal processes to test and assess the performance of control sequences.
• Reduce energy use by 1 quad/year.

Dissemination
• **Deploy through open-source tools and leverage open standards:**
  • Modelica Buildings library and Modelica IBPSA library
• **Create market pull:** work with large building owners and innovative MEP firms who test and demonstrate tools and process on real buildings
• **Establish standardization:** Work with ASHRAE TC
• **Ensure international applicability** (as control vendors are multi-national): Collaborate with control vendors (TAG), ARUP London (self-funded), and IBPSA Project 1
Thank You

LBNL
Michael Wetter & Philip Haves