Improving Organizational Productivity with Building Automation Systems

CABA – IIBC Webinar
10 July 2015
The Continental Automated Buildings Association (CABA) is an international not-for-profit industry association dedicated to the advancement of connected home and building technologies. The organization is supported by an international membership of over 400 organizations involved in the design, manufacturing, installation and retailing of products relating to the Internet of Things for connected homes and intelligent buildings. [www.caba.org](http://www.caba.org)
The CABA Intelligent & Integrated Buildings Council (IIBC) has commissioned the National Research Council (NRC) to lead study a groundbreaking research initiative on “Improving Organizational Productivity with Building Automation Systems”.

This is a collaborative research project which is broken down into 3 phases.

This is a large $150,000 - $200,000 research project that you will be able to join for only $15k
National Research Council Canada – since 1916

- $894.4 Million – 2013-2014 budget
- Over 3,500 employees
- Global reach – work with firms from North America and elsewhere
- Unique multidisciplinary approach
- Activities span the full range of technology sectors
NRC’s unique value proposition

- Working with industry to realize market opportunities
  - timely solutions to complex multidisciplinary problems
  - develop and validate technology
  - shorten time to market
  - speed technology adoption
- Unique research infrastructure & associated expertise
- Trusted 3rd party analysis and evaluation
Enhancing Organizational Productivity

- What is it?
- How do buildings affect it?
- How do we measure it?

- **CABA** and **WGBC** reports
What is Organizational Productivity?

- Output $ / Input $
- Multiple KPIs on both sides of the equation

Salaries
Recruiting
Training
Energy
Raw Materials
Machinery
Computers
HVAC, Lighting
Real Estate
Customer Support ...

Task Design & Performance
Process Design
Management Practices ...

Marketing

Competition
Economic conditions ...

Employee Behaviour

Revenue $
The Cost of Work

- People cost more than buildings by all estimates

Paths to BAS Benefits

- **BAS**
  - Lower energy costs, reduced maintenance, flexibility
  - Better environmental conditions & greater responsiveness
  - Healthier, happier, more effective people
  - Improved organizational productivity
NRC’s Track Record on Organizational Productivity

• Cost-effective Open-Plan Environments: laboratory and field investigations linked workstation design, physical conditions, and job satisfaction

• Lighting Controls: a series of laboratory and field investigations of individual dimming control of workstation lighting: energy savings and occupant benefits

• Green Buildings Post-occupancy Evaluation: energy savings and occupant benefits

• *Example results on following slides…*
Cost-effective Open-Plan Environments

- Satisfaction with lighting
- Satisfaction with privacy & acoustics
- Satisfaction with ventilation
- Overall environmental satisfaction
- Job satisfaction
- Customer satisfaction
- Business-unit performance
- Organizational commitment
- Intent to leave
- Turnover
Environmental Conditions for Value Enhancement

Direct-indirect lighting with individual control:

Post-occupancy Evaluation of Green Buildings

• Green vs. conventional office buildings (N=24) cross-sectional study
• Four sources of data from each building:
  • On-line questionnaire: environmental satisfaction, job satisfaction, health, absenteeism, environmental attitudes, commuting patterns (N=2545)
  • On-site measurements of physical environment (N=974)
  • Interview with building manager: operational issues
  • Energy data: whole building, sub-systems (if available)

Green vs Conventional Example Result
Green buildings score more highly on: aesthetic appearance, view; size of personal workspace; noise from HVAC systems; ventilation & temperature; preferred change in thermal conditions; frequency of thermal adaptive behaviours; workplace image; sleep quality at night (lower scores are better); positive mood; visual and physical discomfort frequency

- Conventional buildings were not better on any outcome
## Tracking BAS Effects: The BAS-Organizational Productivity Scorecard

<table>
<thead>
<tr>
<th>Building Organizational Productivity Label Per Building</th>
<th>This Month</th>
<th>% of Our Target Value</th>
<th>Industry Norm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Score</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental Satisfaction</td>
<td>6</td>
<td>70%</td>
<td></td>
</tr>
<tr>
<td>Job Satisfaction</td>
<td>3.5</td>
<td>50%</td>
<td></td>
</tr>
<tr>
<td>Health Ratings</td>
<td>7</td>
<td>55%</td>
<td></td>
</tr>
<tr>
<td>Staff Commitment</td>
<td>4</td>
<td>50%</td>
<td></td>
</tr>
<tr>
<td>Absenteeism (absence days per 100 employees)</td>
<td>10</td>
<td>10%</td>
<td></td>
</tr>
<tr>
<td>Business Unit Performance</td>
<td>5</td>
<td>55%</td>
<td></td>
</tr>
<tr>
<td>Customer Satisfaction</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial Outcomes</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental Conditions</td>
<td>8</td>
<td>70%</td>
<td></td>
</tr>
<tr>
<td>Average particulate count (µg m⁻³)</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average ventilation rate (air changes per hour)</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average temperature (°C)</td>
<td>22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average articulation index</td>
<td>.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy Use (kWhr/m²)</td>
<td>258</td>
<td>30%</td>
<td></td>
</tr>
<tr>
<td>Lighting</td>
<td>65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heating, Cooling and Ventilation</td>
<td>105</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IT</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plug loads</td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Responsiveness</td>
<td>2.5</td>
<td>35%</td>
<td></td>
</tr>
<tr>
<td>Number of complaints (monthly)</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average response time (days)</td>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Organizations choose categories depending on their priorities
- Enables ongoing monitoring of benefits and fine-tuning systems
Next Steps

- Transform the intelligent integrated buildings industry by demonstrating intelligent building technologies produce organizational productivity gains in addition to energy savings.
- Demonstrate these gains are realized via improvements in indoor environment conditions, and monetize them to show they have value equivalent to other corporate programs.
Phased approach

Phase 1 (cost & duration typical of CABA boutique projects)

• Better building choices: enable decision-makers to evaluate benefits
  • Productivity metrics and building-level benchmark tool

Phase 2 (~1 year)

• Define building characteristics: smart building {BIQ}, green building, granular control, personal control, lighting type, etc.
  • Productivity metrics in terms of building characteristics, one vertical

Phase 3 (~2 years)

• Define physical conditions, mechanisms, and functionality: enabling specifications and partners to monetize specific upgrades
  • Productivity metrics in terms of building functionality & environmental conditions, one vertical
Phase 1: Better building choices

- Based on CABA White Paper scorecard
  *Improving Organizational Productivity with Building Automation Systems*

- Enable decision-makers to:
  - benchmark their building against others on multiple organizational productivity metrics
  - evaluate benefits of building choices (e.g. advanced BAS)
  - Quantify and value relatively
  - Partners can monetize with case-specific knowledge
- Method: Synthesis of existing data
Phase 1: Approach to valuing

Simple example of an organizational productivity metric: Energy

• Studies show green buildings, on average, save 25%

• Building owner can apply building specific costs to estimate the building specific value, with the expectation of this average benefit
Phase 1: Approach to valuing

More challenging example of an organizational productivity metric: Absenteeism

• Extract benchmark data from the literature

- study buildings within the vertical
- other vertical-specific buildings
- other buildings
Phase 1: Approach to valuing

- Project provides paths of equivalent value for reduced absenteeism
  - For example: 1 day/yr/person can be achieved with:
    - Upgraded BAS, or
    - Workplace flu shots
    - Subsidized gym memberships
    - Attendance bonuses, etc.
  - Absenteeism, like energy, has a known context-specific multiplier obtainable from a number of sources, which partners can apply
  - And so on, for other organizational productivity metrics

Analogy is to energy savings and equivalent number of cars taken off the road
Phase 1: Approach to valuing

- Impacts are not independent and not strictly additive
- Project provides averages for planning purposes
- Project partners, or their consultants, can use project data and guidance to make decisions, and go to monetization on their side at their discretion
Phase 2: Productivity defined by building characteristics

- Focus on a particular industry (e.g. financial)
- Partners provide data
- Correlate rich data set
  - Phase 1 metrics (multiple metrics from the same set of buildings)
  - Building characteristics (e.g. green, BIQ, ...)
- Organizational productivity metrics defined in terms of building characteristics
- Results in a more granular decision-making tool than Phase 1, increased accuracy and ability to monetize
Phase 3: Productivity defined by environmental conditions

- Partners choose target vertical(s)
  - Multiple buildings evaluated to NRC protocol
- Detailed on-site physical measurements
  - Lighting (levels, spectrum, etc.), IAQ (VOC, CO2, etc.), noise, etc.
  - On-site technology & functionality (BAS type, integration level, etc.)
- Primary data for metrics of interest
- Productivity metrics in terms of building functionality & environmental conditions, key vertical(s)
- Defines mechanisms by which better systems lead to organizational productivity gains
  - Basis for spec writing, design targets, and manufacturer differentiation
  - Possible monetization at a granular level (e.g. DALI)
Summary

• Proposed CABA project provides a validated framework to estimate economic benefit of investments in smart building technologies
  • Balance of reduced costs and increased value of outputs
  • Basis for corporate decision-making
  • Basis for product specification and differentiation
• Never been done before
  • Transformational for the industry

• Express interest by contacting CABA to participate in Phase 1 of this approved boutique research project
Partnership – Phase 1

• Phase 1
  • Seeking at least 10 partners each contributing $15k
  • Project scope will depend on the total participation

• Phases run in series, so sponsors only get the work they pay for, and they have the chance to upgrade before the next phase starts
Next steps

• Technical questions may be addressed to NRC:
  • Dr. Jennifer Veitch, jennifer.veitch@nrc-cnrc.gc.ca
  • Dr. Alexandra Thompson, alexandra.thompson@nrc-cnrc.gc.ca

• Expressions of interest should be addressed to Greg Walker, Research Director at CABA, by July 31
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Thank you

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Selected Bibliography – Available from NRC


