Identifying and Mitigating Structural Barriers to Diffusion of Energy-Saving Technologies in the Building Industry

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Problem Definition & Project Objectives

Although energy-saving building technologies offer the best available opportunity to reduce GHG emissions with positive NPV and rapid payback, very little progress has been made in implementing them.

Objectives

- Explain whether and how construction industry structure retards the diffusion of energy-saving technologies
- Document successful interventions
- Investigate promising new business models
- Write a Case study of a Successful Firm
## Step 1: Literature review and interviews to analyze effects of industry fragmentation on innovation diffusion

<table>
<thead>
<tr>
<th>Definition</th>
<th>Effects on Innovation Diffusion</th>
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<tbody>
<tr>
<td><strong>Vertical Fragmentation</strong></td>
<td>Lifecycle (design, construction, operations...)</td>
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<tr>
<td><strong>Horizontal Fragmentation</strong></td>
<td>Trade / discipline (mechanical, electrical...)</td>
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<tr>
<td><strong>Longitudinal Fragmentation</strong></td>
<td>Over time (from project to project)</td>
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</table>
| **Additional Factors** | Additional market barriers | • Extreme demand fluctuation “strands” invested capital and deters debt financing  
• Technological risk aversion due to liability |

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Step 2: Analyze effects of innovation span and team integration on implementation of energy-saving technologies in LEED buildings

**Methodology**
- Examine implementation of 73 types of energy-saving building technologies in 114 LEED-certified buildings in the US
- Use binary logistic regressions with generalized estimating equations to analyze impacts of innovation span on likelihood of implementation, and moderating role of team integration

**Innovation Span**
- Modular innovations – innovations that do not alter standard interfaces or processes (e.g., efficient light bulbs, fixture sensors). Local improvements.
- Integral innovations – innovations that alter standard interfaces or processes (e.g., building management system, UFAD). Global, system-wide improvements.

**Findings**
- Modular innovations implemented almost three times as often as integral innovations (42% and 17% of the time, respectively)
- Integrated MEP firms implement more modular innovations (49% vs. 39%); no difference in integral innovations (17% vs. 16%)
Work in progress and future directions

**Work in Progress**

- **Doctoral dissertation in progress**: Barriers to the diffusion of energy-saving building innovations (student – Dana Sheffer, adviser – Prof. Raymond Levitt, CEE)
- **Articles in preparation**
  - How industry fragmentation retards diffusion of innovations in construction
  - The effects of innovation span and horizontal team integration on implementation of energy-saving building innovations
  - Supply-chain reconfiguration as a strategic tool to increase adoption of energy-saving innovations
- **Joint CEE/GSB business and engineering case study** on Zeta Communities Inc., innovative provider of low-cost, net zero energy prefabricated homes
- **Conference presentations**: Engineering Project Organization, Nov 2010, Aug 2011

**Next Steps**

- Investigate strategies to increase implementation of integral innovations
- Examine impact of vertical and longitudinal integration on innovation implementation
- Develop dynamic model of energy-efficient innovation implementation in buildings