"The Future of the Building Envelope... Building Upon Our Past"

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Overview

- The 13th! Conference
  - Innovation, sustainability, future
  - 1st conference: Eric Burnett / Vlad Stritesky
- Some meandering thoughts
  - on the past
  - current challenges and research
  - Future opportunities and obstacles

What is Building Science?

- *The collection of knowledge surrounding the prediction and understanding of building performance*
  - Not structural, not quite HVAC, not air quality….
  - Not just enclosures: "envelopes"
  - Canadian focus: moisture, energy, air quality
  - European building physics: add fire, sound, light
- Must combine physics with field experience
- Much more development needed to reach sophistication of structural engineering

Global MegaTrends

- Global population is growing
- Global affluence is growing
- Demand for all resources growing as **Population × Resources**
- This drives up prices
- *Buildings consume more energy and resources than any other single human activity*
- **Hence, Sustainability and Energy**

The past: Neil Hutcheon 1961

Enclosure design 50 years ago

"Designs for exterior walls for buildings have seldom been developed in a systematic, rational way. They have evolved slowly ….

Today, with a dynamic architecture and many new materials, components and construction techniques available, a large number of new designs are possible ….

Unfortunately, some are being adopted without adequate consideration, and evaluation by the slow trial-by-use methods of the past is no longer adequate."

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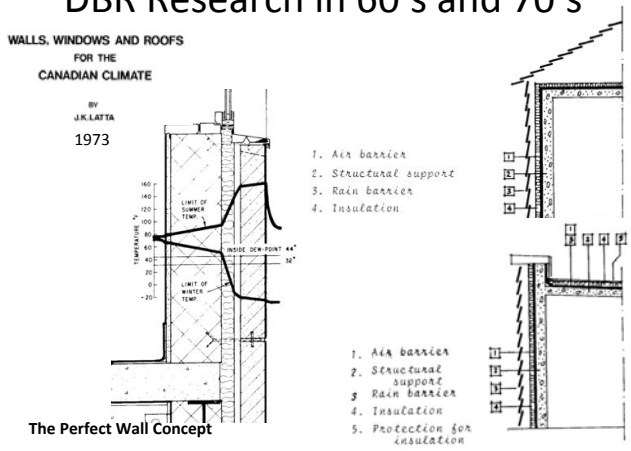
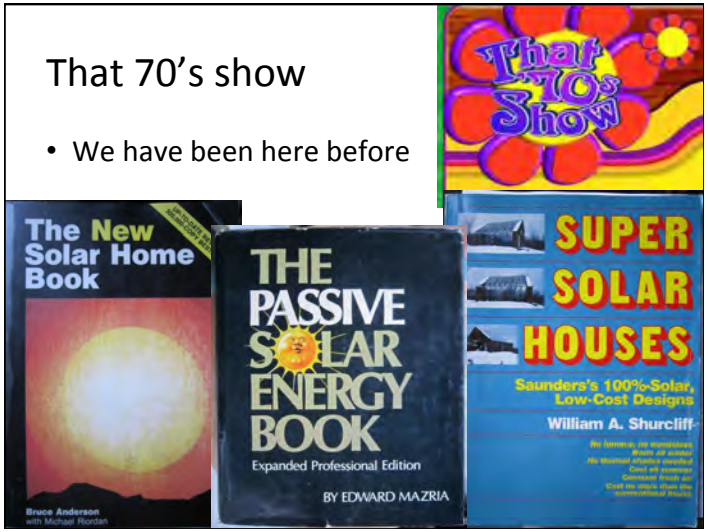
DBR Research in 60's and 70's

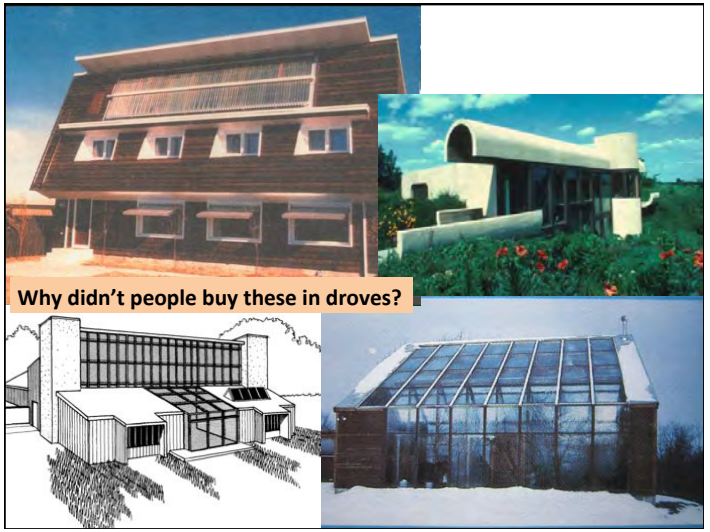


The Perfect Wall Concept

That 70's show

- We have been here before





Why didn't people buy these in droves?

What we learned

- Most people don't like weird stuff
- Most people don't like discomfort
- Complex and mechanical things break
- Insulation does not wear out or break
- Airtightness is critical
- Balance energy with comfort and aesthetics
- House is a system: durability, IAQ can be compromised by focus on energy

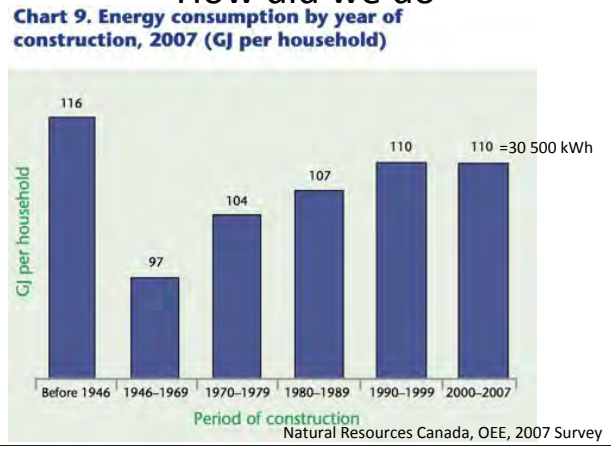
The past: two views

- Nothing has changed:
  - physics, models, and experience must be used to predict performance
  - Still little science applied to buildings
- Everything has changed:
  - Different materials and systems are available
  - Higher expectations have driven high-performance solutions to become normal

Lessons applied to today

- Lots of airtightness and insulation
- Exceptional rain control, more drying capacity
- Windows are critical, beware over-glazing
- Make it look mostly normal

How did we do

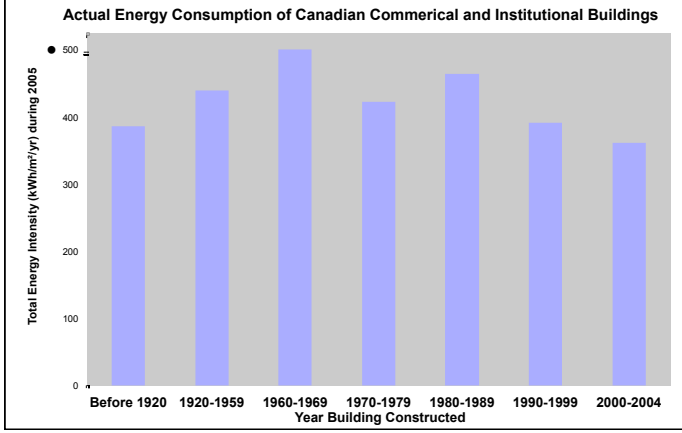


Natural Resources Canada, OEE, 2007 Survey

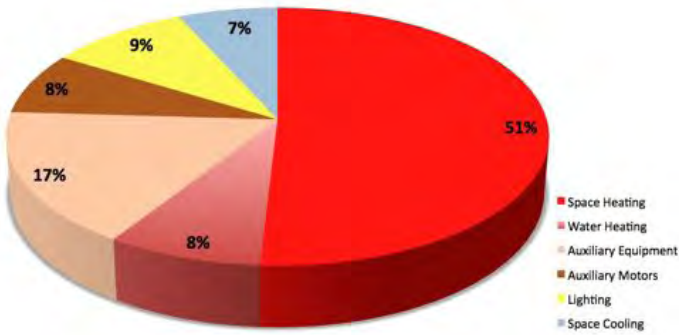
How did we fail

- Low energy prices
- Increased house size / complexity
  - Significant increases in 50 years
- Failed to increase insulation
  - Most codes languishing
- Failed to adopt window technology
  - "good" windows are R3 or so.
- We did airtighten and improve combustion

Commercial Buildings by yr built



Canadian Office Buildings 2007



Building Science Today

- Environmental damage/consumption
- Buildings don't always work well
  - Comfort, durability, leaks, maintenance
- Buildings can cost too much
- Buildings can make us puke

- Lots for Building Science to do!

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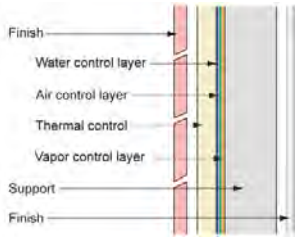
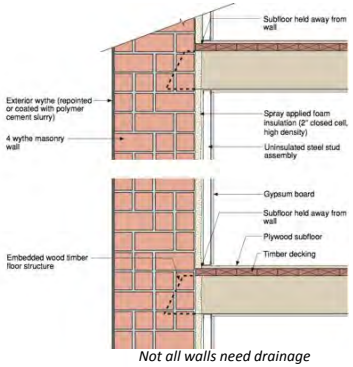
Dogma in the 2010's

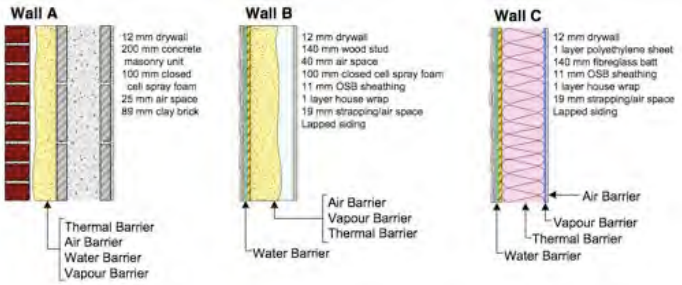


The "Perfect" Enclosure



Not all walls need drainage
Not all vapor barriers are poly

Confusion reigns



Why require a 10 mm drainage gap? Science shows 1 mm is plenty.

Air Barriers / Vapor Barriers

- Ronald Brand (1990) on commercial buildings
  - *It has been explained above ... that barriers against the diffusion of water vapour are seldom, if ever, needed, in spite of code requirements to the contrary. The real concern is that they may be expected to serve as air barriers. .. polyethylene film['s] useful life is uncertain, it is not strong enough to withstand wind loads; it cannot be sealed to the structural members that must penetrate it, and it cannot be made to adhere to other parts of the structure.*

Diffusion Confusion Eg. ccSPF

- The science is clear: ccSPF provide their own vapor control
  - Why does the code stand in the way?
- Unvented low-slope roofs with ccSPF insulation are time-proven, scientifically supported
  - Why does the code stand in the way of pitched roofs?

Innovation: Nice but not necessary

- Insulation
  - Some new products, e.g. BASF Neopor
  - VIPs may become available
  - ICFs (structure, air + thermal + vapor)
  - Spray insulation, (air + water) control
- Fluid applied (air + water +vapor? control)
- Doing what's right is the innovation needed
- **But**, we *can* get 2x-5x R-value by
  - Continuity (blunt thermal bridges), and
  - adding thickness

Need more than technology

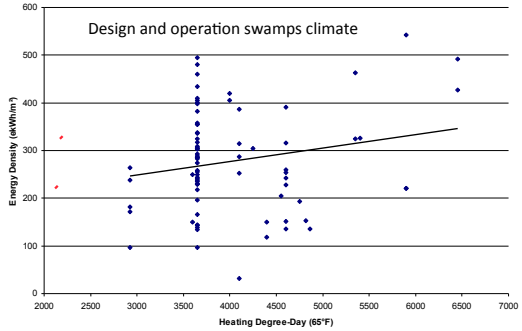
- We need different
  - Values (performance matters)
  - Skills (reliable prediction)
  - Knowledge & Understanding
    - Developed by education, training, experience
    - Need research to feed into this process!

Reality check

- Real performance is what matters
- Sometimes understanding can't keep up
- Real measured performance needed
  - Real buildings
  - Real test walls, windows, roofs, heat pumps
- Need feedback to guide science
- Need feed forward to code
  - E.g. vapour barriers

MURBS:Vancouver vs Edmonton

- How much does climate really matter?



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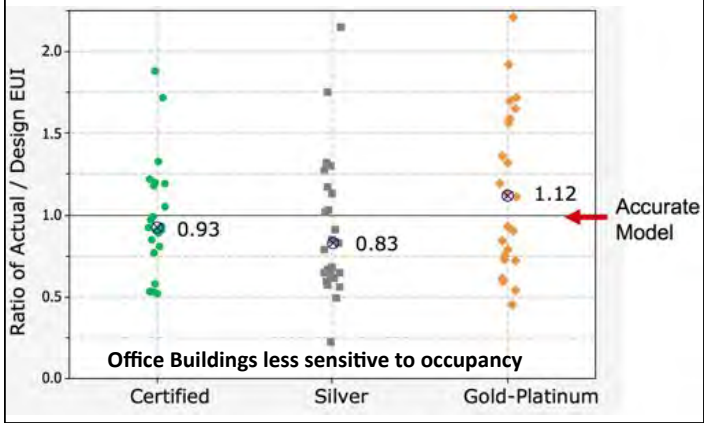
Energy Models

- Are critical to guide energy-efficient design
  - Mostly used as compliance tools (LEED)
  - Need more design guidance, esp early stage
- GIGO Garbage in = garbage out
- No control of quality/accuracy
- Need to compare measured results to modeled results!
  - We need to tune our models, public info needed

Energy Model vs Measured Data



Occupancy vs model

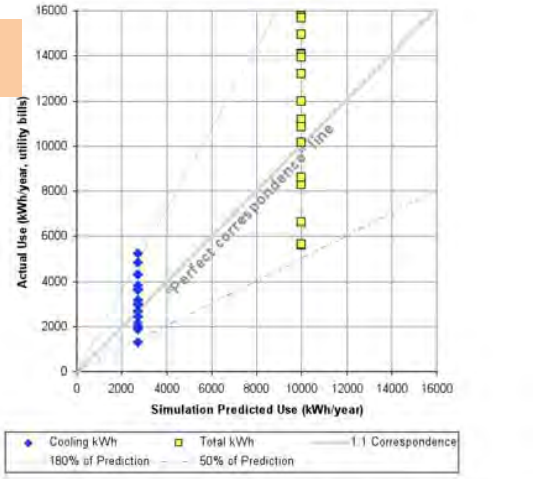
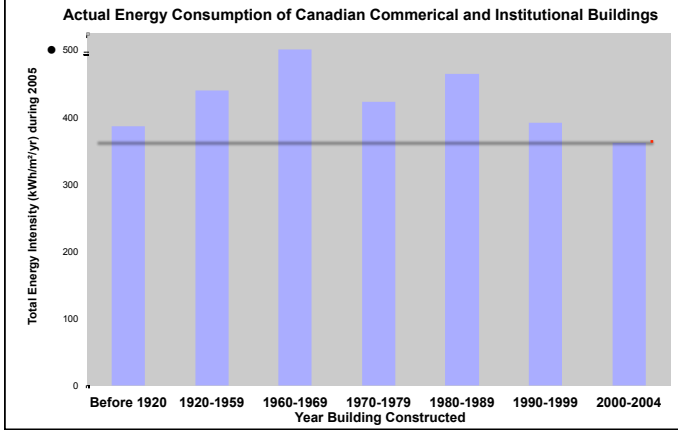


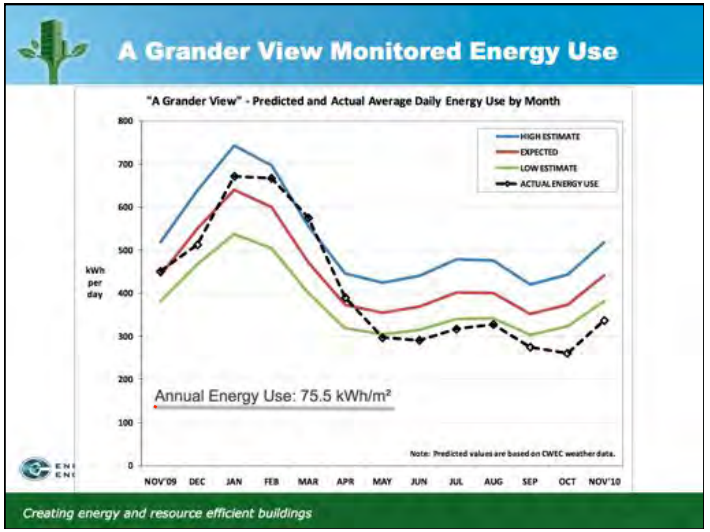
Figure 1: Simulation (horizontal) vs. actual (vertical) electric use for 17 identical houses in Oklahoma

Commercial Buildings by yr built

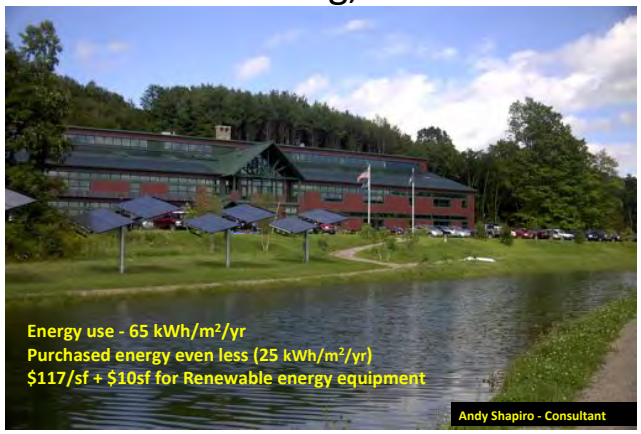


Grander View, 2010

- Mostly simple, standard technology
- Modest cost premium

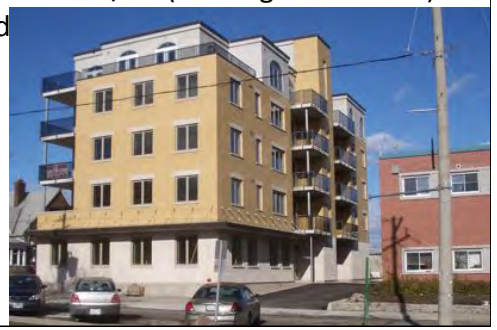


NRG Building, Vermont



Waterloo Apartment / Office

- Built for median cost in 2005
- Less than 100 ekWh/m^2 (Ont avg around 250)
- All standard products



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Waterloo Region Health & Welfare

- Built 1990. 160 ekWh/m^2/yr. Less than half national average

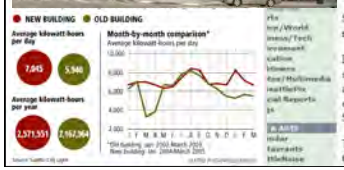
London City Hall

"Greenest city hall in the world" 2002
"Virtually non-polluting" 2011

London UK City Hall

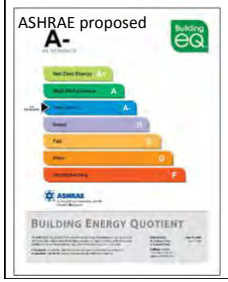
- Measured: 376 kWh/m^2/yr

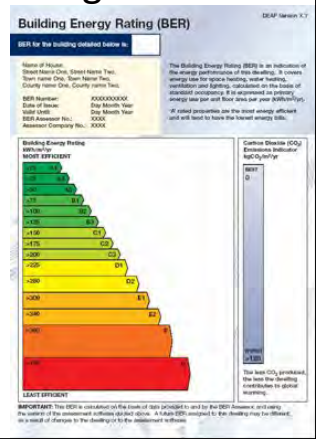
Seattle City Hall



Energy Labeling

- Can cut through fluff
- Real data not promises, points or plaques



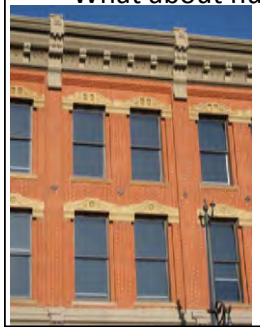


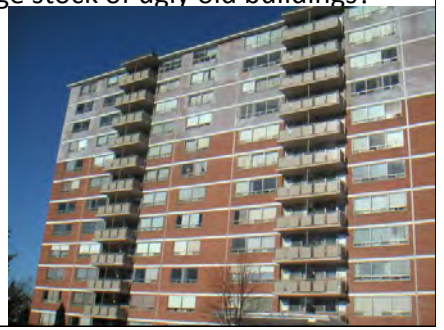
We know how

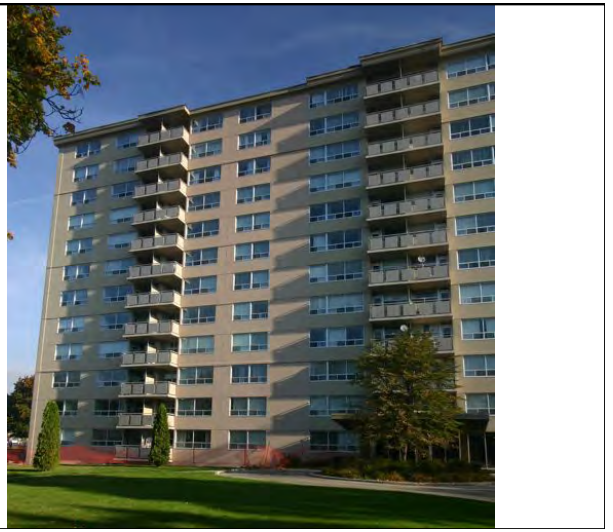
- Getting to ½, even ¼ is possible, mostly practical
- BUT, requires
  - Knowledgeable, integrated design team
  - Performance tracking during design
  - owner who cares
- Does NOT need
  - Expensive new widgets, complex HVAC, controls
  - Checklists aka LEED

"Heritage" Buildings

- "Old buildings that are nice" = heritage
- What about huge stock of ugly old buildings?







Future

- We need much better buildings
- But we know most of how to go there
- Cant forget Indoor Air Quality, light, view, fire, cost, durability etc
- Need to apply good science mixed with good experience: building science
- Need to remove obstacles, work on implementation, deployment

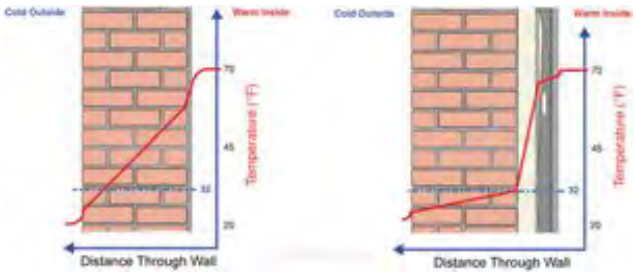
Radical thoughts

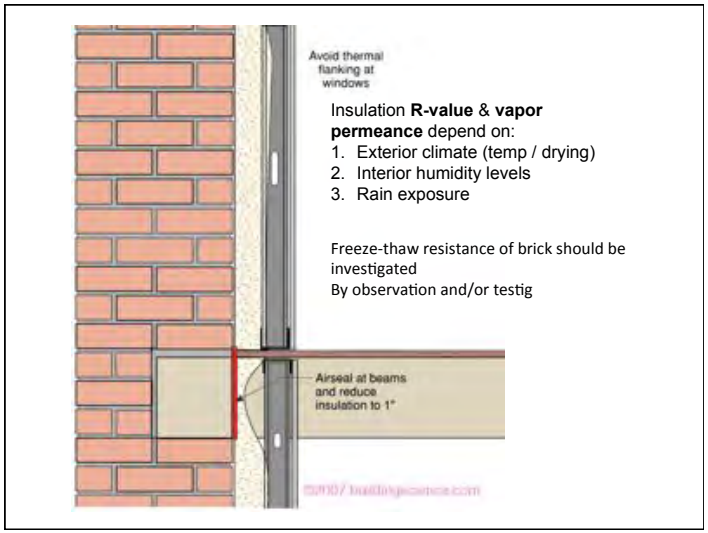
- Simple systems to manage complexity
  - Continuous control layers on exterior
  - Small scale distributed HVAC
  - Floor by floor HVAC in office towers
  - Individual suite HVAC in MURBs
  - Limited central controls, “supervisory” BAS

Summary

- Big short-fall in translation of what some know to what most do
- **Biggest need is education**
- Research is needed in many areas
- Most critical: tools to help change design, construction, and operation for the better
- Need real data, not promises and plaques

Interior Insulation




Avoid thermal flanking at windows
Insulation **R-value** & **vapor permeance** depend on:
1. Exterior climate (temp / drying)
2. Interior humidity levels
3. Rain exposure
Freeze-thaw resistance of brick should be investigated
By observation and/or testig
Airseal at beams and reduce insulation to 1"


Harvard Blackstone Bldg
Bruner Cott Architects

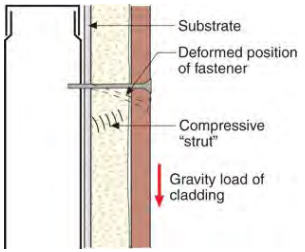
Deep energy retrofits

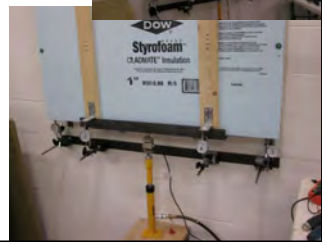
- Total shell renewal on the exterior
- Gut rehab of mechanical

Foam sheathing testing

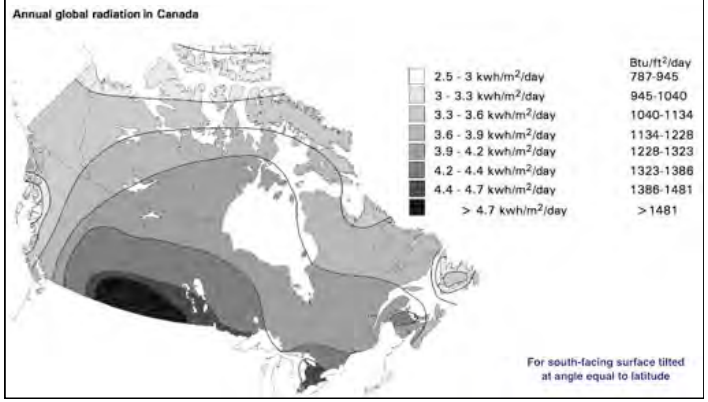
Exterior insulation

- Insulating on exterior is not a structural challenge
- Experience and testing





Solar Resources



Rolf Disch, Freiburg Germany (wikipedia)

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