Understanding the Green Architect as Master Builder: Saviour or Sinner

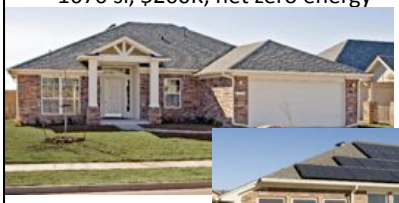
Dr John Straube
Building Science Corporation
University of Waterloo

Architectural Record

- House of the month

Ideal Homes OK

- 1670 sf, $200K, net zero energy



Is it Green? Learning to count

- Depends on answers to:
  - Does it use less non renewable energy to operate?
  - Will it last longer? (less life-cycle resources)
  - Does it use fewer non renewable resources to build?
  - Does it pollute less?
  - Does it displace fewer habitats?
- Compared to what?:
  - Zero (sustainable)
  - Average (move forward, "green")

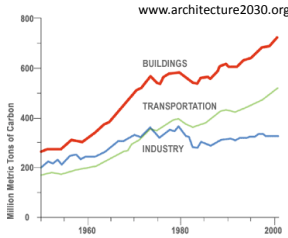
"Sustainable" buildings

- "Can keep doing what we are doing indefinitely"
  - *Sustainable development is development which meets the needs of the present without compromising the ability of future generations to meet their own needs.*
    Bruntland Commission Report – the source and inspiration for the popularization of the concept of sustainability
  - A sustainable society, process, or product is one that can be sustained or continue to be produced over the long term, without adversely affecting the natural conditions (e.g, soil, ecosystem, water quality, climate, etc) necessary to support those same activities in the future.
  - Even the greenest buildings today are not sustainable

Mazria 2030 Challenge

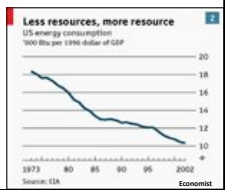
- Set targets, measure performance
  - 60% reduction by 2010

www.architecture2030.org/news/targets.html

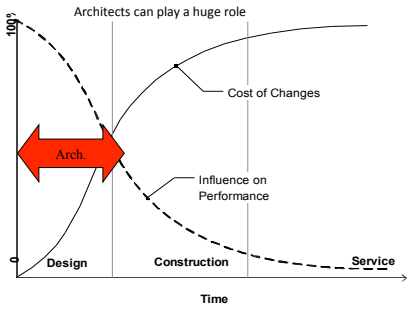


And the answer is …Efficiency

- People want services not energy
  - Warm house, not gas
  - Light, not electricity
- Hence, efficiency allow us to have our cake and eat it
- Energy reductions after '73 / '79
- California brownouts(2001):
  - 14% cut in 6 months simply by citizen action



Design & Performance vs Cost

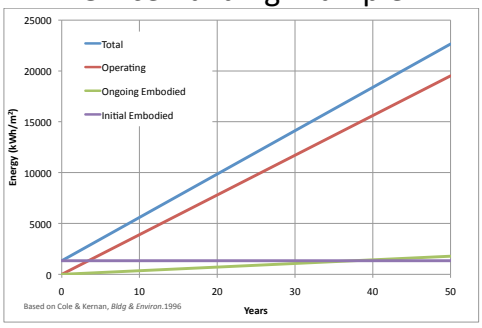


Environmental Damage

- Resource Extraction
  - Cutting trees, mining, drilling oil, etc.
- Processing
  - Refining, melting, etc. Pollutants and energy
- Transportation
  - Mass and Mode (ship/truck) and Mileage
- Construction
  - Energy, worker transport
- Operational Energy

The Majority of Impact

Office Building Example



"Good" Buildings

•Green Buildings are just one part of Good Buildings

•Must consider all aspects of the whole system

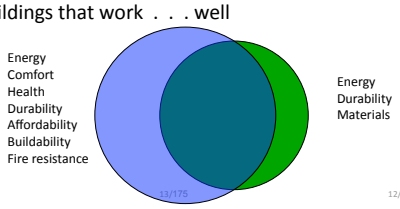
- Functional
  - meet the program of present & future occupants
- Healthy
  - few chemicals given off, no mould, fresh air
- Durable
  - so that they can be used for a long time
- Adaptable
  - for many uses so they can be re-used easily
- Energy efficient
  - in operation and in construction
- Capital Efficient
  - to allow investment on other uses
- Non-polluting
  - in operation and production

High performance Buildings

- Snazzy term for good buildings
  - Functional, energy efficient, durable, affordable, adaptable, healthy
- Green Buildings should be High Performance
  - No magic material, widget
  - A systems approach is required
  - Trade-offs, compromises, competence
  - Systems Design, Holisitic

Building Science=Green Buildings

- What is Building Science
  - The science of making buildings that work
- What are Green Buildings
  - Buildings that work . . . well



Designing for high performance

- Durability and Efficiency are the focus
  - Largely involves the massing, form, enclosure
- Health, comfort, and affordability result from above when done right
- Architects must still concern themselves with planning space and process

Getting Green

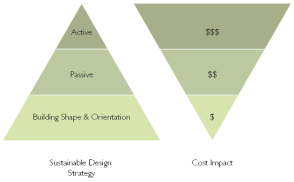
- Siting
  - Orient with sun, wind, rain, earth shelter?
- Shape and Form
  - Compact, simple
- Exceptional building enclosure
  - Insulated, airtight, durable, solar control
- Efficienct Equipment
  - Not there or off is best
- Renewable Energy Generation

Approach

- Climate, Site, Form and Massing
  - Make choices and accommodation
  - Near zero cost impacts
- Enclosure Design
  - Invest resources in capital to reduce on-going energy, repair, maintenance
  - Often costs
- Active (Mechanical) systems
  - Choose efficient, right-size

Energy Saving Strategies

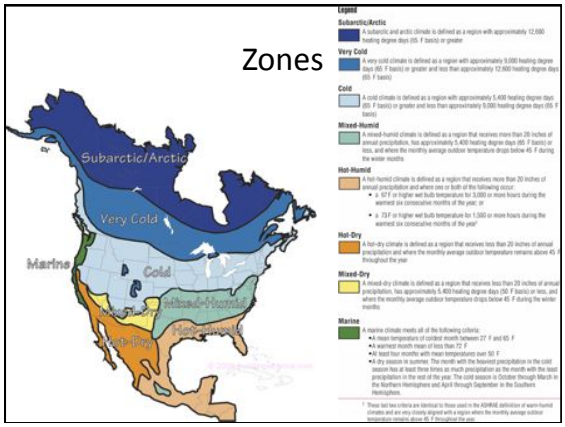
- Proper choices early on result in no or little in increased cost



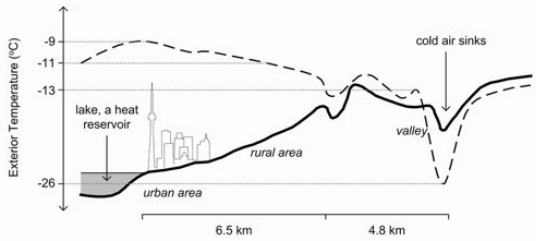
Site

- Climate!
  - Hot? cold? both?
- Site
  - Earth Sheltering
  - Slope
  - Footprint / damage
  - Tree lines, ponds

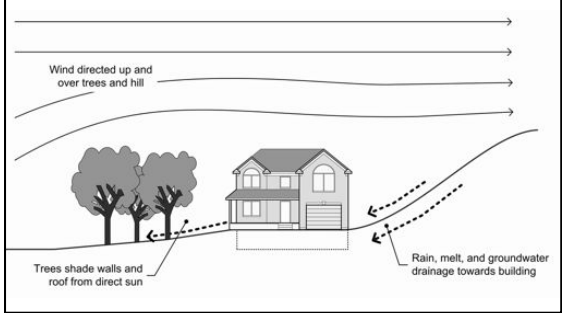
Zones



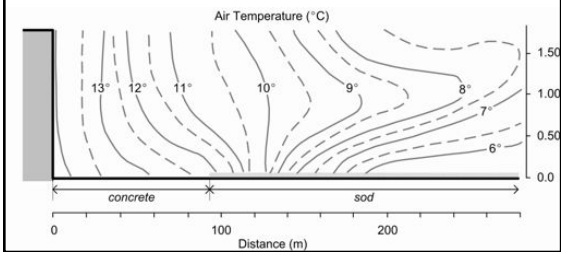
Regional microclimate



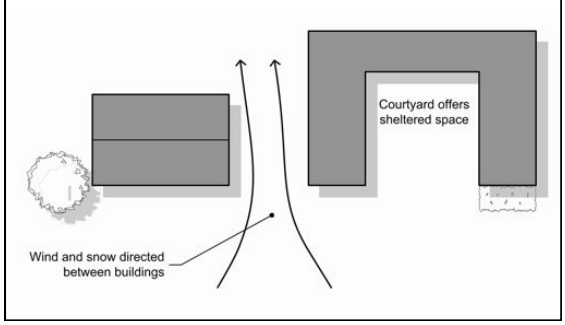
Site-specific microclimate



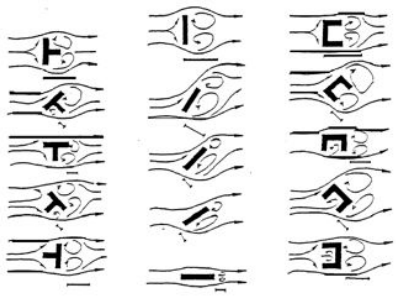
Building Microclimate



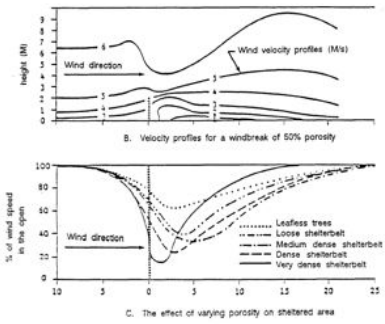
Building Specific Microclimate



Wind Channeling



Wind breaks

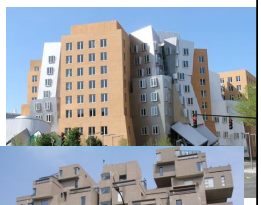


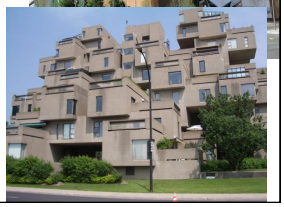
Small, Compact Form

- Fewer resources
- Less heat loss and gain

Form & Massing

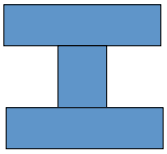
- Keep it simple
- Cheaper, easier, faster
- Fewer
  - thermal bridges, air leaks
  - Material volumes
  - construction challenges





Expanded Plans

- Better daylight, easier ventilation
- but more enclosure heat loss and gain and air leaks so still need better enclosure



Trade offs

- Large rectangular buildings have a reduced surface to volume ratio
  - Equals lower heat loss and gain
- Complex building shapes increase surface area
  - Heat loss and gain increase
  - Require better insulation and solar control

Basic Goals (cold/mixed)

- Keep heat in
  - When it is cold
- Keep heat / sun out
  - When it is warm/hot

Insulation
Airtightness
Solar Control

- Last a long time
  - Reduce construction/repair resources over time

Rain Control

- Use efficient equipment
  - Efficient lighting
  - Efficient computers, elevators

Off is very efficient

Basic Goals (hot-humid)

- Keep heat in
  - When it is cold (easy)
- Keep heat / sun out
  - When it is warm/hot

Solar Control*
Airtightness
Insulation

- Last a long time
  - Reduce construction/repair resources over time

Rain Humidity / UV

- Use efficient equipment
  - Efficient lighting
  - Efficient computers, elevators

Off is very efficient

Basic Goals (hot-cold dry)

- Keep heat in
  - When it is cold (easy)
- Keep heat / sun out
  - When it is warm/hot

Solar Control*
Airtightness
Insulation
Thermal mass

- Last a long time
  - Reduce construction/repair resources over time

Rain Control / UV

- Use efficient equipment
  - Efficient lighting
  - Efficient computers, elevators

Off is very efficient

Strategies- Airtightness

- Airtightness critical for all climates
  - Humidity loads from air critical health comfort and durability issue in hot-humid
  - Control condensation and energy waste critical in cold climates
  - Natural ventilation useful in dry (night) and moderate climates (e.g., marine)

Strategies- Insulation

- Resists heat loss/gain = energy savings
  - Large temperature differences: cold and hot climates, roofs (hot)
  - Less important in warm-humid and mixed climates
- Warms surfaces = durability
  - Avoids condensation in hot and cold weather
  - = durability and health strategy
  - Keep structure warm and dry and stable

Strategies- Solar Control

- Solar gain and rejection
  - Can make use of solar heat gain in enclosure dominated buildings in cold/mixed climates
  - Must reject/shade sun in hot-humid, hot-dry
- Passive Solar: great enclosures means glazing ratio must go down or overheating!
  - 10-15% window to floor area, OR lower solar heat gain coefficient
  - Better operable shades

Strategies- Rain control

- Rain Control = manage moisture
  - Critical to Durability
  - Common mold/health problem
- High wind and rain zones requires care
  - Exposure very important, not just rainfall zone!
  - High-rise exposed more than low-rise

Solar Management

- Collect when you want
  - Usually cold climate
  - Mixed/dry climate during cold weather
  - Easy to over-do
- Avoid when you don't
  - This is more important for insulated, airtight buildings that are internal gain dominated

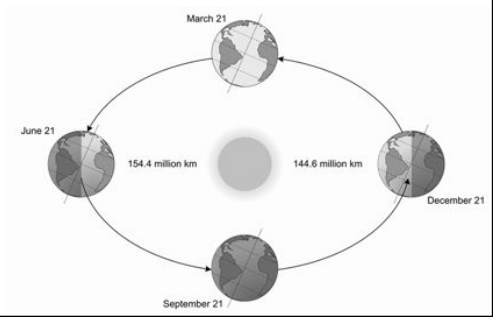
Strategies- Humidity Control

- Interior Humidity = moisture
- Cold weather require lower RH
  - to stop surface condensation (mold)
  - To avoid interstitial condensation (durability)
- Humid weather require lower RH
  - To control condensation on cold surfaces (mold)
  - separate dehumidification in humid climates
  - East of Mississippi River has humid summers

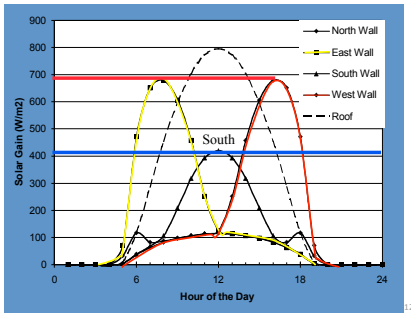
Strategies- Thermal mass

- Structure may provide thermal mass
  - Encourage interaction with the interior
    - (no carpets, leave exposed ceiling)
    - Must allow inside temperature to swing (e.g. 70-76 F)
    - Better insulation means greater mass effect
- Thermal mass allows one to
  - Shift peak loads
  - Collect solar heat or cool for later
- Requires careful design to take advantage of

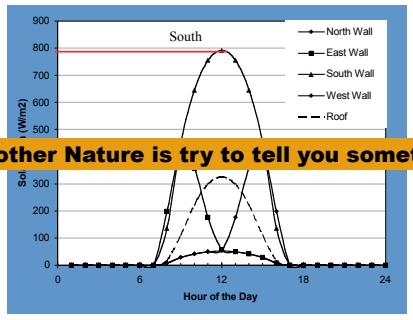
The Sun is predictable!



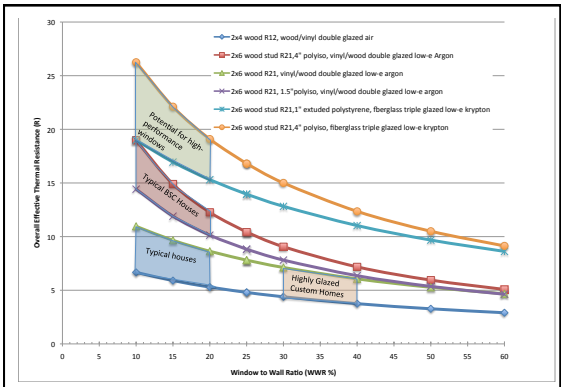
Solar Gains - July 21 @45 N



Solar Gains - Jan 21 @ 45 N



Mother Nature is try to tell you something



Building Science 2008

Good Practice

- Structure
  - connect all parts together to foundation
- Continuous Rain Control
  - Drainage plane, gap and flashing is needed
- Continuous Insulation
  - Exterior insulation layer to slow heat flow, blunt cold spots (R>5-10)
- Air barrier
  - Continuous air barrier to control air flow
  - Vapor retarder less important, may have holes

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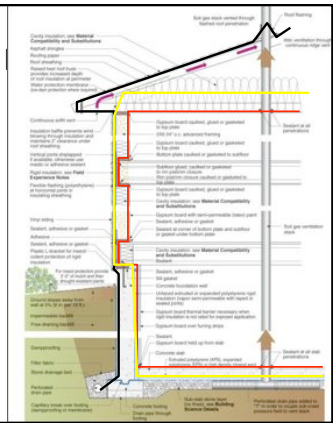
- Rain
- Heat
- Air



How much insulation?

- Regardless of type, use *more*
- For Comfort & Moisture Control
  - **True** R5-10 is enough (!), but …..
- For energy and the environment
  - As much as practical & economical
  - Cold/mixed R20-40 walls, R25-60 roofs, Slabs R5-15, basements R10-20
  - Hot R15-25 walls, R20-40 roofs, slabs 5-10
- reduce HVAC capital cost as well as operating!

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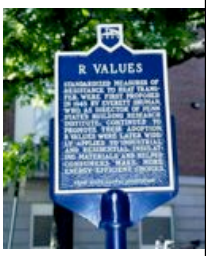
New systems

SIPS

ICF

Insulation vs R-value

- R-value= material
- We build systems
  - Thermal bridging
  - Air leakage
  - Installation
  - Thermal mass



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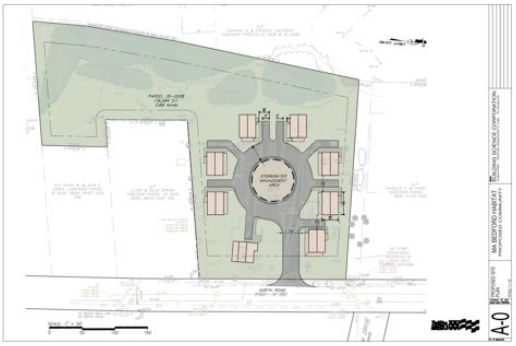
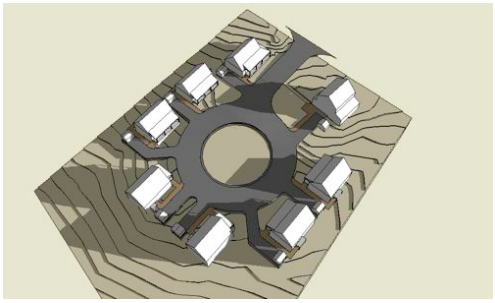
How to do it

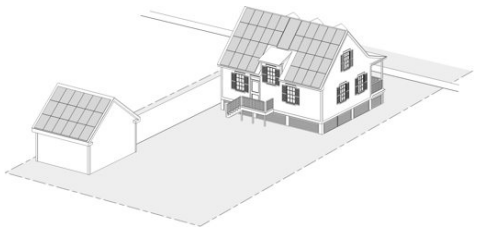
- Count - energy and resources
- System integration
  - "Professional specialization" disease
  - Sub-system optimization
  - Non-optimal whole system design
- Real benefits come as a system, not individual
  - Airtight, shade and solar windows save AC costs, fans, and ducts
  - Better insulation can mean no furnace
  - Reduced power req't = alternative energy economical

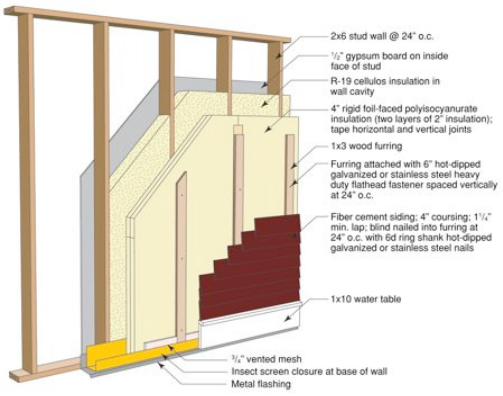


3-D Model of Proposed Development

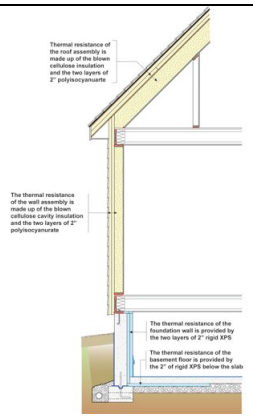


Building Shape

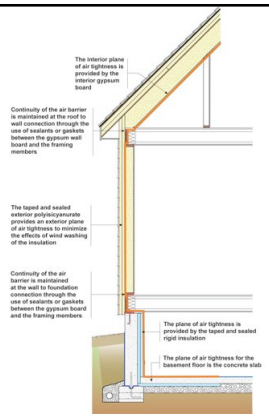




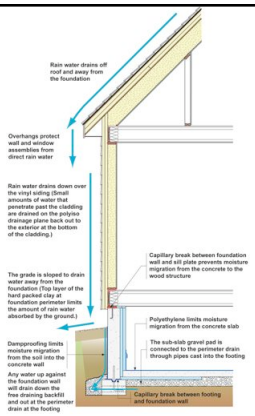
Bedford Thermal Insulation System



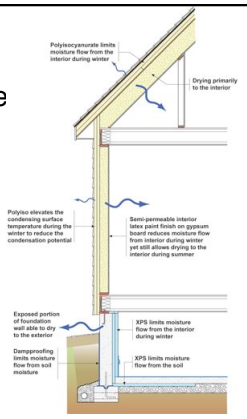
Bedford
Air Flow
Retarder
System

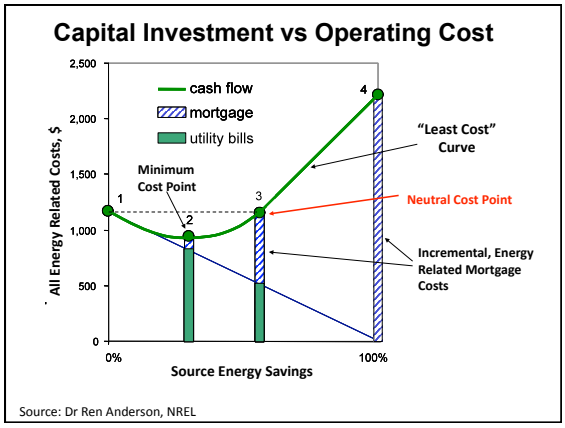


Bedford
Water
Management
System



Bedford
Vapor Retarde
System





Source: Dr Ren Anderson, NREL

Conlusions

- Low Energy buildings push the need for integrated, holistic designs to new limits
- Architects need to understand the technology, and quantify (roughly) its benefits