Building Science Basics

Building Science Basics

- Knowledge of building science can help improve the performance of homes
  - Cost
  - Comfort
  - Durability
  - Efficiency

Why Building Science?

- Provides greater understanding of aspects of house and their interaction
- Enables consideration of comfort, cost, durability and efficiency
- Helps make wise trade-offs among options available

Building Science Definition

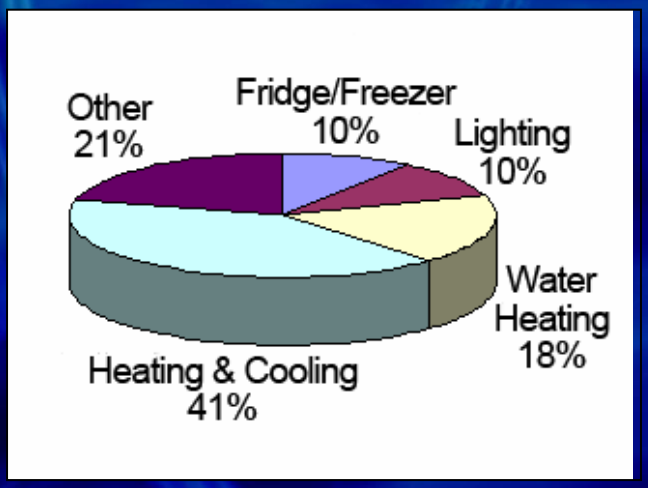
A.K.A. *building physics* or *building dynamics*

- The study of the interaction between
  - Occupants
  - Building components/systems, and
  - Environment
- Focusing on flows of
  - Heat
  - Air
  - Moisture

Occupant Focus

- Comfort issues
  - Even temperatures, no drafts
  - Healthy humidity levels (winter and summer)
  - Mold and other allergens
- Cost issues
  - Remodeling project
  - Energy, maintenance and repair costs

Residential Energy Use

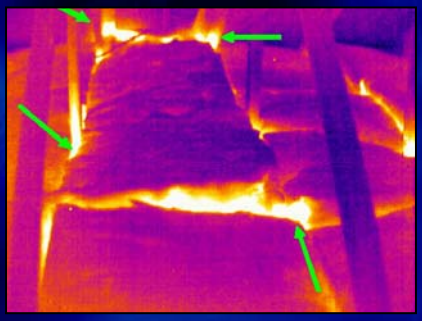


Heat, Air, and Moisture Flows in Houses

- Heat **moves from hot → cold**
- Air **moves from higher → lower pressure**
- Moisture **moves from wetter → drier areas**

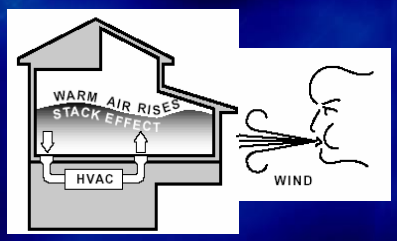
Surface Heat Transfer

- Conduction
- Convection
- Radiation



Air Movement and Infiltration

- Conditions for air infiltration
  - Pressure difference (high to low)
  - Penetrations in building envelope (holes and cracks)
- Driving forces
  - Temperature difference (stack effect)
  - Wind
  - Mechanical systems



Moisture Levels

- Building decay ……100% RH
- Interior mold……RH > 70%
- Dust mites……... RH > 50%
- Static electricity & dry sinus.. RH < 25%

Ideal Health & Comfort is 30%-50% RH at room temperature (~72° F)

Moisture Flow in Buildings

Moisture flows in two forms:

LIQUID	VAPOR
Bulk	Diffusion
Capillary	Infiltration

Encountering Water Vapor

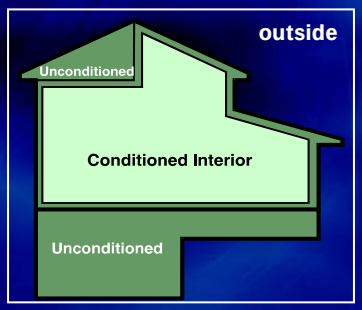
Impact of Environment on Home and Occupants

Factors affecting human comfort

- Temperature
- Relative humidity
- Precipitation
- Wind
- Solar radiation

Interaction Among House Components

- Building envelope
  - Continuous air barrier
  - Complete insulation coverage
- Proper heating and cooling systems
- Controlled ventilation



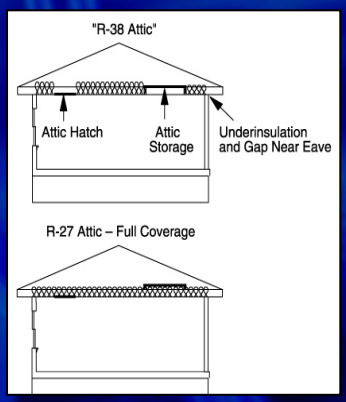
The building envelope includes two elements: an air barrier and insulation that must be continuous & in contact with one another

Locate the Building Envelope

Strategies to Control Heat Flow

- Insulate to reduce conduction
- Control air flow to reduce infiltration/convection
- Provide shading/select windows to control heat absorbed

Installing insulation coverage is key!



R-38 installed with 5% gaps or uninsulated areas yields the same heat loss as R-27 with full coverage - a 30% reduction!

1000 s.f of Attic
950 s.f. is R-38
50 s.f. is R-4

The Myth of Focusing on Insulation

- **Myth: To improve the energy efficiency of a home, just add more insulation!**

- **Fact: Reducing air infiltration can improve energy efficiency more than insulation.**

Tradeoffs: Increased Insulation vs. Reduced Air Leakage

	Annual Utility Bill Savings	
	Air Changes/ Hr .80→.40	Attic Insul. R-11→R-38
Ft. Worth, TX	$162	$73
Raleigh, NC	$177	$83
Syracuse, NY	$394	$248

Strategies to Control Air Flow

- Block infiltration and convection pathways to attics and crawlspaces
- Seal leaky joints in walls, floors and ceilings
- Seal attic scuttles
- Seal ductwork in unconditioned space
- Balance pressures within house

Air Flow Examples
Pathways in Attics

Air Flow Examples
Pathways in Attics

Air Flow Examples
Pathways in Kneewalls

Controlling Air Flow
Fixing a Chase

Air Sealing after Drywall

- Outlets to drywall
- Fixtures to drywall (recessed lights airtight IC-rated)
- Boots to drywall
- Attic stairs to drywall

Air Sealing after Drywall

Attic scuttle holes must seal tight - requires weatherstripping

Controlling Air Flow - Sealed Crawlspaces

- Seal ground with concrete and/or plastic
- Insulate exterior walls per code
- Eliminate vents and seal leaks (e.g., access door)
- Provide dampered supply duct to space, or exhaust air from space with a radon vent or similar system

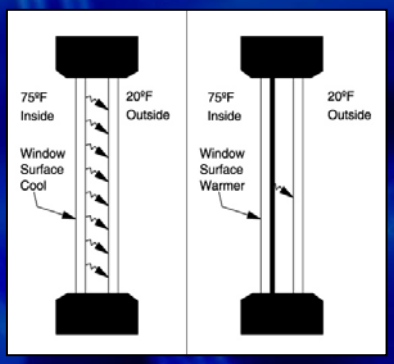
Requirements:

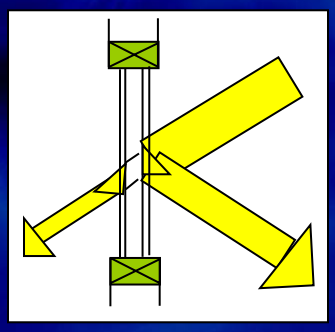
- No drainage problems
- If HVAC in crawl, replace with sealed combustion/ direct vent furnace or install a heat pump
- Pest Control and Code Officials approve your approach

Strategies to Control Radiation

- Radiant barrier in attic
- Low-E windows
- Infrared-reflective roofing
- Shading devices
- Roof overhangs

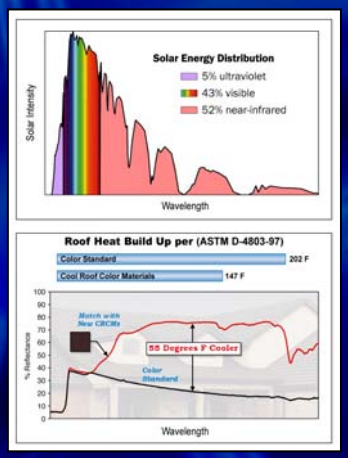
Controlling Radiation
Low-E Windows





A low-E window optimized for summer would likely have the coating on the outer pane's inside surface

Controlling Radiation
Reflective Roofing



Strategies to Control Moisture Flow

- Water at foundations
- Water and vapor at walls
- Water at window flashing
- Water through design
- Vapor moisture with material's permeability

Water Control
Walls - Housewrap Details

Windows
(incorrectly) have
flange over
housewrap

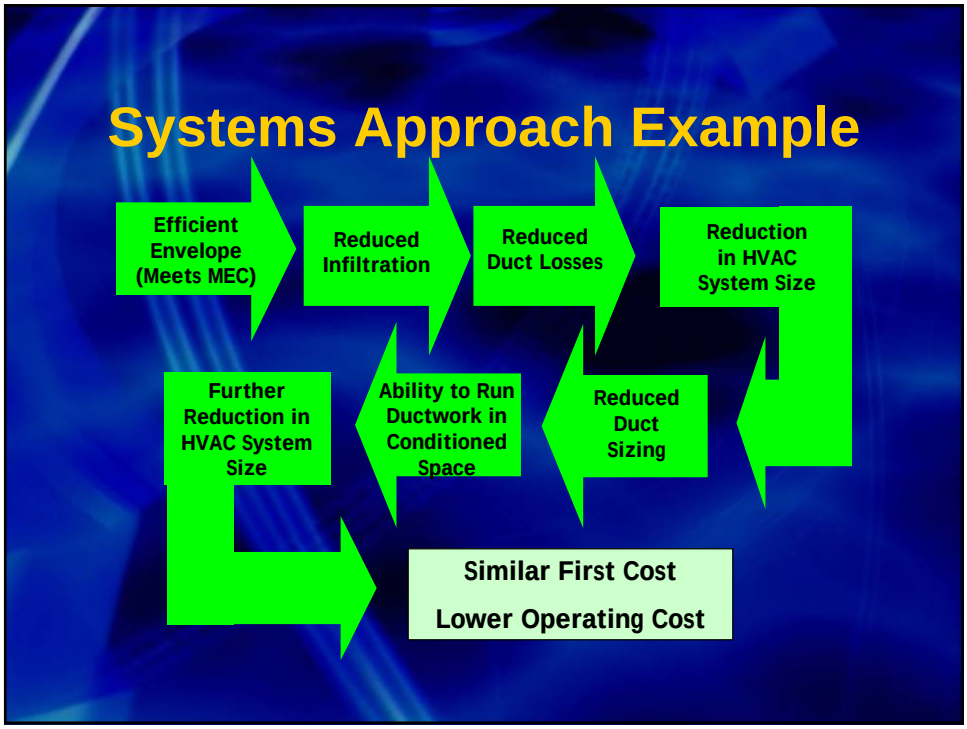
Rotten Header

Summary

- Building science studies the interaction between occupants, building components and systems, and the environment by focusing on flows of heat and air
- Use building science to help you improve the performance (cost, comfort, durability, and efficiency) of remodeled homes

Why Evaluate the House as a System?

- **To improve home performance**
- **To improve living environment**
- **To make the right recommendations**
- **To optimize choices**
  (example: one system, two benefits)


Systems Approach Example
Efficient Envelope (Meets MEC)
Reduced Infiltration
Reduced Duct Losses
Reduction in HVAC System Size
Reduced Duct Sizing
Ability to Run Ductwork in Conditioned Space
Further Reduction in HVAC System Size
Similar First Cost
Lower Operating Cost

Other Benefits of a Whole-House Approach
• Minimize mold lawsuits
• Less risk of allergies
• Increase durability
• Reduce callbacks
• Better product