



Learning Objectives

- Identify the changes that have occurred in the way that we build and use houses and the risks to designers, homebuilders and others in the industry of these changes.
- Identify the fundamentals of building science and how builders can use science to solve a wide range of building problems, improve home performance and reduce risks
- Learn to use the science of houses to assist in the evaluation and specification of designs, building materials and methods.
- Practice using the language of building science to improve communication with suppliers, trade partners and home buyers
- Apply building science principles to building elements
 - Water management details
 - Insulation and air sealing details
 - Understanding windows
 - Indoor air quality
 - Better mechanical systems
 - Advanced Building Technologies



For more information:

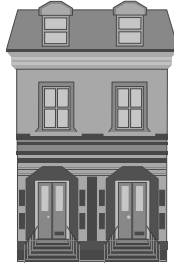
www.eeba.org
www.energystar.gov
www.buildingamerica.gov

Building Science Overview

One of the most important lessons learned from 30 years of extensive housing research and experience is that the many changes in design, building materials, mechanical systems, appliances, consumer lifestyles and expectations, make houses more complex than ever before. A much more comprehensive systems approach, embracing the fundamentals of building science, is needed to respond to the higher expectations of consumers.

Record examples of things that have changed in houses or the way we live in houses.

House Design & Materials



Mechanical Systems

Consumer Expectations & Lifestyle

Environment

Building Science is about the Flow of 3 things:

- _____ We put more _____ into our homes.
- _____ We add more _____ into our homes.
- _____ There is more competition for _____ in homes.

High Performance Homes:

1. Tight construction
2. Improved insulation
3. High performance windows
4. Efficient HVAC systems – properly designed
5. Tight ducts
6. Efficient water heating
7. Ventilation
8. Efficient lights and appliances
9. Renewable energy sources

High performance homes are also “green” homes

Houses That Work

- Safer
- More comfortable
- More energy efficient
- Healthier
- More durable

*All elements work together as a system
–when you change one thing it affects
all others*

All builders need to understand the risks & opportunities in building high performance homes.

- How long do we want houses to last? _____
- Know the risks associated with your local conditions:

Building Science Basics

Heat Flow

Heat Flow Mechanisms:

1. Conduction - _____
2. Radiation - _____
3. Convection - _____

Conduction heat flow:

Heat (BTUs) = $\frac{\text{Area} \times \text{Temp. Diff.}}{\text{R-Value}}$

Example: 1000 ft². 135 F attic, 75 F inside:

Heat Flow = _____ x _____ / _____ = _____

If you double insulation you cut conduction heat gain in _____

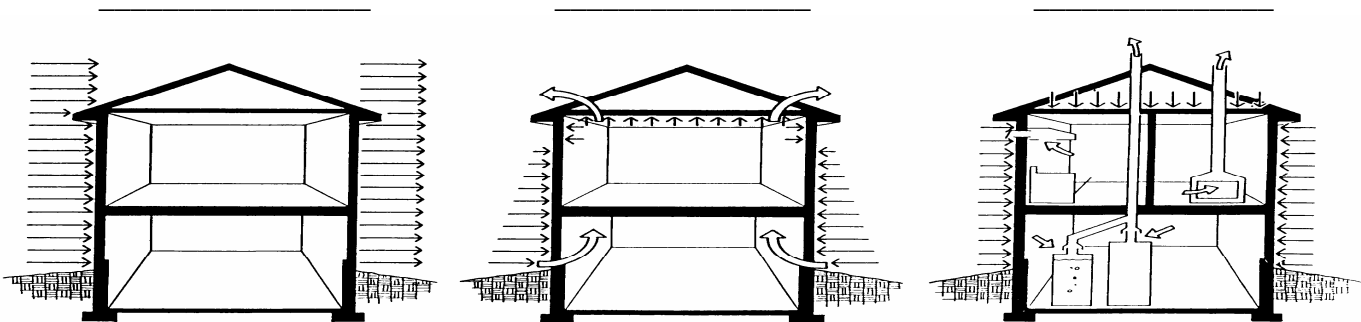
Heat flows from _____ to _____,
Warm air _____

Thermal comfort is a function of at least:

1. Air temperature
2. _____
3. Humidity
4. Air movement / drafts
5. Occupant activity and sensitivity

Air Flow:

Three mechanisms for air flow:



Moisture Flow:

Moisture Flow Mechanisms

1. Rain / Gravity driven - _____
2. Capillary - _____
3. Air flow - _____
4. Diffusion - _____

These are in order of priority

Moisture in liquid form destroys houses

Moisture moves from _____ to _____

Moisture moves from _____ to _____

Moisture moves with _____

It's all about _____ of _____

80% of construction litigation is moisture related.

What are your most pressing building science issues as of today?

Heat Flow: _____

Air Flow: _____

Moisture Flow: _____

- What trades do you need to involve right away? _____

Commit to a process of continual improvement

Who in you company is responsible for building science? _____

- Who needs training?

- How many days per month / per year do you need to set aside for training/ _____

<p><u>Controlling Air Flow – The Big Holes</u></p> <p>1. _____</p> <p>2. _____</p> <p>3. _____</p> <p>4. _____</p> <p>5. _____</p> <p style="text-align: center;"><i>Simple, inexpensive materials</i></p> <ul style="list-style-type: none"> • _____ • _____ 	<p>Interior Air Barriers can be used, they would include:</p> <ul style="list-style-type: none"> • Air tight drywall approach • Caulking or foam of penetrations • Air tight light & electrical fixtures • Draft stops in critical areas <p>Exterior Air Barriers can be used, they would include:</p> <ul style="list-style-type: none"> • Detailing the weather barrier • Sealing penetrations <p style="text-align: center;"><i>Test your houses for air tightness:</i></p>
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<p><i>Why do we want houses to be airtight?</i></p> <p>1. _____</p> <p>2. _____</p> <p>3. _____</p> <p>4. _____</p> <p>5. _____</p>	<p><i>What concerns regarding houses being too tight do we have to address?</i></p> <p>1. _____</p> <p>2. _____</p> <p>3. _____</p>
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Air tightness really only becomes an issue when you air condition homes and insulate

Insulation:

In order for insulation to work effectively: No _____, No _____, No _____

- Air tight and dry
- Its not about the perfect material, it is about using _____ and installing it correctly
- Attic insulation: Unvented attics can be found in the Builder Guide.
- ***What will you change to improve your insulation systems?***

1. _____
2. _____

Innovative Wall Systems:

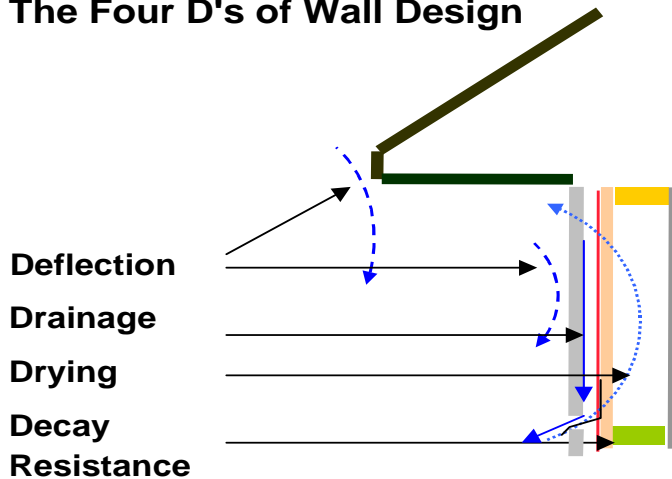
Technology	Advantages	Ideas for Overcoming Barriers
ICF		
Advanced Framing		

Windows

- Windows account for up to _____ of AC loads, avoid _____ facing glass and properly shade _____ facing. Harvest wind for natural cooling and use north glass for daylighting
- Radiant gains through glass in summer leads to _____ complaints.
- 4 important technologies:
 - Low E coatings SHGC of less than _____
 - Insulated spacers
 - U values of less than _____, may be achieved with argon gas fill.
 - Better frame technologies _____
- Let your AC contractor know your ratings so they can size equipment appropriately

Water Management

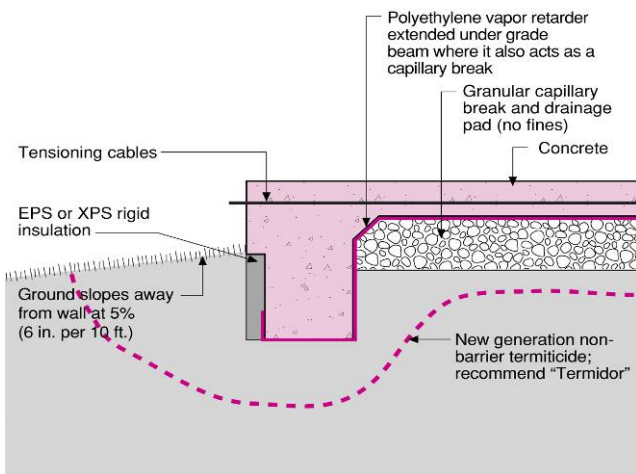
The Four D's of Wall Design



Water Management Principles

- Know your water management risks
- Don't rely on caulking / tapes, design for a _____ effect to drain water.
- Air gaps of _____" promote good drainage
- Prepare and plan for _____
- Protect openings with good _____
- It's less about the materials and more about the _____. That said, choose materials that are easy to detail.

Foundations



Capillary Breaks

- _____
- _____

Foundation Principles

1. Hold up the building
2. Keep liquid water & vapor out
3. Let water and vapor out if it gets in
4. Control heat flow
5. Keep pests out

Drain: Get water at least _____' from wall

- _____
- _____

Other notes:

Mechanical Systems

- Challenge your HVAC contractor to get the sizing right for cooling & heating, avoid over sizing
 - Know your “design day” conditions: Summer _____, Winter _____
 - Provide your contractor with critical information: _____ & _____

Bigger is not better, don't oversize by more than 10 – 15%, smaller is better

Proper sizing AC improves: _____, _____ & _____
Contractors should be using Manual J calculations for your temperature and humidity

What elements help to reduce cooling loads?

- _____
- _____
- A great new technology is ECM fan motors; they reduce fan power consumption by _____% and improve dehumidification effectiveness by up to _____%.
- In some climates, the removal of moisture or latent loads can be up to half of the total air conditioning load.

Specify AC units with high Seasonal Energy Efficiency Ratings (SEER).

- SEER is the cooling output divided by the wattage used by the unit.
- A 13 SEER unit uses 30% less electricity than a 10 SEER unit.
- Properly match the AC coil to the air handler fan

What other HVAC decisions are important?

- Ducts leak at the rate of 30%, test them and seal them with _____
- Be sure ducts are always in “conditioned” space
- Better planning of framing and floor joists can optimize duct systems

Lastly move towards DIRECT VENT or POWER VENT combustion appliances, they improve:

- _____ & _____ & _____
- If you must have natural draft combustion appliances, test houses for depressurization to ensure exhaust fans won't backdraft chimneys.
- Chimneys can reliably overcome negative pressures of only 5 Pa or 0.02” of static.

Test Your Houses for Performance

Programs such as ENERGY STAR require performance testing of homes; this is a good thing. What tests could be performed to help ensure you have built a high performance home?

- _____
- _____

How tight is tight?

We often use the term “Equivalent Leakage Area” to measure air tightness. An older 2000 sq.ft. home might have an ELA of more than 600 sq.in. A really tight house would be below 100 sq.in.

Indoor Air Quality & Ventilation

List at least four things that have made IAQ a bigger concern than before.

1. _____
2. _____
3. _____
4. _____

IAQ Solution Strategies

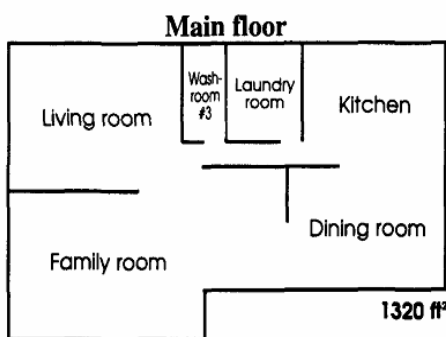
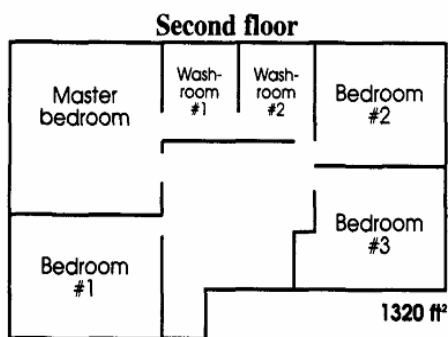
In order of Priority

1. _____
2. _____
3. _____
4. _____

Ventilation

- What types of houses need mechanical ventilation? _____

The formula for ventilation capacity is: (# of bedrooms +1) x 7.5 CFM + 0.01 x sq.ft.



Example:

2640 sq.ft., 4 bedroom home

(____ +1) x 7.5 + _____ x 0.01

= _____ CFM

There are a number of Mechanical Ventilation alternatives:

- Good quiet bath fans – Sound levels of less than ____ sone, timers to extend operation time.
- Fresh air intake into an air handler duct – typically ____” dia., damper and timer controls.
- Heat / Energy Recovery Ventilator – balanced ventilation with up to ____% energy savings.

Appliances and Lighting

- Appliances and lighting can account for as much as ____% of total energy use.
- They have a double impact as they also increase AC loads
- Appliances can also have a significant impact on _____ use and the use of chemicals
- A new ENERGY STAR refrigerator uses _____ the amount of energy as a 20 yr. old unit.

Help your customers make better decisions for these elements that have a 20 year impact.

Marketing

- Educate your customers, leverage your efforts, get active with ENERGY STAR.
- Energy efficiency is currently one of the most important things on buyers more
 - The price of energy is at an all time high, the cost of borrowing is near all time lows
 - This means energy efficiency has a better ROI than any other investment
 - Eg. A \$10,000 investment in energy efficiency can realize annual energy savings of at least \$1,000. This is a ____% ROI; compare this to current borrowing rates ____.

Energy Conservation is an excellent investment

The same things you do to make house more efficient also make them safer, healthier more comfortable and more durable – these happen to be the primary principles of “green” buildings.

Today has been a lot about building science, but in order to make changes you will have to change complicated processes. Create a plan to get started.

Houses That Work Action Plan				
Tasks	Done	This Month	This Year	Future
Identify the building science team within your company	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Benchmark your current construction – air test, duct leakage test, HVAC sizing, water management systems, combustion safety	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Review exterior water management details: <ul style="list-style-type: none"> • Window and roof flashings, Weather barrier detailing • Capillary flow and drainage details 	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Implement air tightness improvements – draft stopping, air barrier details	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Review window specifications and be sure your HVAC contractor is using the appropriate window data	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Assess insulation effectiveness and implement an improvement plan	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Review HVAC sizing and duct design and make changes necessary to optimize performance	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Incorporate a fresh air ventilation strategy into your HVAC plan	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Review specifications of water heaters, appliances and lighting – include options in your marketing materials for higher performance	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Implement a training plan for design, contracts and site staff	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Implement a training plan for your sales people to include information on building science and technical elements	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Include training requirements in your scopes of work for trades	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Consider building a demonstration home to showcase new technologies or methods	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

On behalf of EEBA and our valuable education sponsors, Thank you for your participation.

Now go forth and change the industry in which you work, we will be there to help.

