What is a Building?
A Building is an Environmental Separator
• Control heat flow
• Control airflow
• Control water vapor flow
• Control rain
• Control ground water
• Control light and solar radiation
• Control noise and vibrations
• Control contaminants, environmental hazards and odors
• Control insects, rodents and vermin
• Control fire
• Provide strength and rigidity
• Be durable
• Be aesthetically pleasing
• Be economical
Order of Magnitude
Order of Magnitude
1 to 10
10 to 100
100 to 1000
1000 to 10000
First Order Effects, Second Order Effects....
Arrhenius Equation
For Every 10 Degree K Rise
Reaction Rate Doubles

\[ k = A e^{-E_a/(RT)} \]
Damage Functions
Water
Heat
Ultra-violet Radiation
The Three Biggest Problems In Buildings Are Water, Water and Water...
80 Percent of all Construction Problems are Related to Water
Thermodynamics
Zeroth Law – Equal Systems
First Law - Conservation of Energy
Second Law - Entropy
Third Law – Absolute Zero
2\textsuperscript{nd} Law of Thermodynamics
In an isolated system, a process can occur only if it increases the total entropy of the system

Rudolf Clausius
Heat Flow Is From Warm To Cold
Moisture Flow Is From Warm To Cold
Moisture Flow Is From More To Less
Air Flow Is From A Higher Pressure to a Lower Pressure
Gravity Acts Down
Moisture Flow Is From Warm To Cold
Moisture Flow Is From More To Less
Moisture Flow Is From Warm To Cold
Moisture Flow Is From More To Less

Thermal Gradient – Thermal Diffusion
Concentration Gradient – Molecular Diffusion
Moisture Flow Is From Warm To Cold
Moisture Flow Is From More To Less

Thermal Gradient – Thermal Diffusion
Concentration Gradient – Molecular Diffusion

Vapor Diffusion
Thermodynamic Potential
PSYCHROMETRIC CHART
NORMAL TEMPERATURES
SI METRIC UNITS
Barometric Pressure 101.325 kPa
SEA LEVEL
Water Control Layer
Air Control Layer
Vapor Control Layer
Thermal Control Layer
Cladding
Control layers
Structure
Configurations of the Perfect Wall
Brick veneer/stone veneer

Drained cavity

Exterior rigid insulation — extruded polystyrene, expanded polystyrene, isocyanurate, rock wool, fiberglass

Membrane or trowel-on or spray applied drainage plane, air barrier and vapor retarder

Concrete block

Metal channel or wood furring

Gypsum board

Latex paint or vapor semi-permeable textured wall finish

Vapor Profile
Building Science Corporation

Brick veneer/stone veneer

Drained cavity

Exterior rigid insulation — extruded polystyrene, expanded polystyrene, isocyanurate, rock wool, fiberglass

Membrane or trowel-on or spray applied drainage plane, air barrier and vapor retarder

Non paper-faced exterior gypsum sheathing, plywood or oriented strand board (OSB)

Uninsulated steel stud cavity

Gypsum board

Latex paint or vapor semi-permeable textured wall finish

Vapor Profile
Brick veneer/stone veneer

Drained cavity

Exterior rigid insulation — extruded polystyrene, expanded polystyrene, isocyanurate, rock wool, fiberglass

Membrane or trowel-on or spray applied drainage plane, air barrier and vapor retarder

Non paper-faced exterior gypsum sheathing, plywood or oriented strand board (OSB)

Insulated wood stud cavity

Gypsum board

Latex paint or vapor semi-permeable textured wall finish

Vapor Profile
Commercial Enclosure: Simple Layers

- Structure
- Rain/Air/Vapor
- Insulation
- Finish
<table>
<thead>
<tr>
<th>Pascals</th>
<th>mph</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 Pa</td>
<td>20 mph</td>
</tr>
<tr>
<td>100 Pa</td>
<td>30 mph</td>
</tr>
<tr>
<td>150 Pa</td>
<td>35 mph</td>
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<tr>
<td>250 Pa</td>
<td>45 mph</td>
</tr>
<tr>
<td>500 Pa</td>
<td>65 mph</td>
</tr>
<tr>
<td>1,000 Pa</td>
<td>90 mph</td>
</tr>
</tbody>
</table>

Wind Speed (mph) vs. Stagnation Pressure (Pa)
Rain Screen
Beer Screen?
Rain enters cup due to momentum ("kinetic energy")

Cup drains water to exterior
Rain enters cup due to momentum ("kinetic energy")

Wind enters cup—pressurizing cup; no rain entry due to wind driven rain

Cup can still drain water to exterior

Entire wind pressure taken here
Baffle to deflect raindrops hitting face of cup due to momentum ("kinetic energy")

Pressure in cup is same as pressure outside on face of baffle.

Momentum driving force converted to gravity—water drains away.

Wind enters cup—pressurizing cup; no rain entry due to wind driven rain.

Cup can still drain water to exterior.

Entire wind pressure taken here.
Insulating glass unit

Seal (gasket)

Seal (tape)

Setting block (typically two per unit)

Hole providing drainage and pressurization

Frame

Rough opening
Outer seal sees water but not pressure; no pressure difference across this seal, therefore no rain entry.

Key seal is interior seal as it takes maximum wind load but it does not see water.

Pressure in chamber is same as pressure outside on face of assembly.

Air enters and pressurizes chamber.

Entire wind pressure taken here.

Pressure chamber.
Intent of sealant is to limit this lateral flow of water between sheathing and building wrap.

Flashing tape

Sealant “bedding” joint

Building wrap “wrapped” into opening
Wind pressurizes chamber between inner and outer seal.

- Sealant backer rod
- Inner seal
- Sealant backer rod
- Outer seal
- Vent tube
Inner, protected seal

Outer, exposed seal

Drain and vent opening
Life is Tough Enough As it Is…
Life is Tough Enough As it Is…
It’s Harder When You Are Stupid
Don’t Do Stupid Things
WEDGE SHIMS INSERTED BEHIND/FRONT OF ANGLE TO ENSURE DIRECT BEARING ON BRACKET AND PROVIDE LEVEL (IF NECESSARY)

ANCHOR BOLT

FAST™ BRACKET

ANGLE