Physical Environmental Factors

• How Buildings Work
• Importance of Ventilation On Learning
• Moisture Control
How Buildings Work
Do To The Cold Weather
Please Leave The Faucets Running
Remember who you designing for...
Indoor Climate

• Thermal comfort zone:
  – 70 degrees F to 85 degrees F
  – 20% to 80% RH

• Actual surface temperatures in building vary
What planet is this and why am I here?
- Dr. Who

North American Conditioning Climates
(Lstiburek)
To Avoid Problems the Enclosure Must:

- Manage the flow of rainwater/groundwater
- Manage the flow of air
- Manage the flow of heat (and sunlight)
- Manage the flow of water vapor
- Manage the migration of creatures
The Enclosure

Continuity Test for control of air, rainwater, heat and water vapor
NYSERDA Homepic project house

Something you should know: The crappy stuff works better than you’d think and the good stuff doesn’t work as well as you’d think.
Tracing rainwater control from the center of the roof to the center of the foundation
Tracing continuity of thermal control from the center of the roof to the bottom of the foundation.
Tracing continuity of air flow control from the center of the roof to the center of the foundation floor.
FSEC Study on Unplanned Airflows in Florida

- ducts were 70 times leakier than SMACNA Standard (1.2CFM250/100sq.ft.duct)
- suspended ceilings were 10 times leakier than sheetrock
- Repair of unplanned airflow problems reduced cooling loads by 15% at an average cost of $454/ building
Avoiding Condensation in wall assemblies

• Make it airtight in all climates
• Put all the materials with low perm (perm less than 2) on one side or the other of cavity
• Make one of the low materials at least an inch foam board
• Winter humidity less than the average January temperature plus 6
Moisture Control in Buildings
Moisture Related Problems

• Pest colonization (if you build it they will come)
  – termites, ants, fungi, bacteria
  – wood, MDF, OSB, paper, adhesives, textiles, paints

• Physical /Chemical
  – Corrodes, swells, warps, peels, dissolves, gooey smelly mess (hydrolysis)
  – metal, wood, paints, flooring adhesives, paper gyp board, MDF, latex emulsions
Moisture Sources

- Poorly managed rainwater/groundwater
- Plumbing leaks
- Condensation on surface
- Construction moisture
- Spilled, tracked, water vapor
Top Ten Things to Do If You Want to grow mold

• Build below the 100 year flood level
• Drain the rain into the building (or a river runs through it)
• Put a vapor barrier on both sides of a wall (or roof) or on the cool side of a wall (or roof)
• Suck or blow hot humid air onto cold surfaces (no air barrier – big holes and no pressure control)
• Don’t exhaust baths, dryers or range hood
• Oversize air conditioners
• Make it hard to inspect and clean cooling coils and ductwork down stream of coils
• Don’t pressure test the plumbing and put it where you can’t tell when it leaks
• Paint, cover or enclose really wet porous stuff
• Use really good mold food in places that are gonna get wet
Preventing and Fixing Moisture Problems

- Drainage/Capillary breaks
- Accessible tested plumbing/drains
- Manage water vapor
  - Exhaust vent sources
  - Layer envelope/warm surfaces
  - Manage airflows (airtightness/dilution ventilation)
  - Dehumidify
- Dry newly installed wet materials
- Use moisture and mold resistant materials in locations that will get wet
Holistic Design Team

- Owner
- Architects, engineers
- Construction management
- Commissioning agent
- Builders, subs
- Buildings and grounds?
Design for Moisture Control

• How important is moisture control to the owner, to you?

• Provide moisture control detail in construction documents:
  – Building
  – During construction
  – O&M
  – Verification, testing and remedies
The Contents

1. Moisture Control Principles
   - Control Water Intrusion
   - Control Humidity
2. Design for Moisture Control
   - Storm Water Management
   - Enclosure Design
   - Mechanical & Plumbing System Design
3. Moisture Control during Construction
4. Moisture Control during O&M
5. Tools
Consider water
Some materials can tolerate:

- Soaking, sopping wet dampness for a long time with no problems
- Periodic superficial wetting as long as they dry quickly enough
- Any wetting what-so-ever
Pick the right site
Engineering solution for picking a poor site
Drain the site...
...into the building?
...what the @#$%?
Drain the rain...

From roofs

Most roof leaks are at the penetrations and edges
Cheap but effective rain protection for parapet
Expensive, but ineffective moisture protection for parapets
From walls
Where roofs run into walls
Retrofit through wall flashing - $150 - $400/foot
Drain the walls and windows
Workmanship is important
Wind driven rain leaks through windows and rusts bolts holding on concrete panels
The old way – carved stone pan flashing
Sill flash windows
This third century Roman ceramic tile floor has lasted for nearly 2000 years.
No ducts under slabs (on or below grade)
Basement Rules

- Drainage and capillary break
- No paper or wooden products touch foundation materials
- Keep warm summer air from contact with earth chilled surfaces using foam insulation
- Put a drain in the floor
Capillary suction wicks water through porous materials.
Capillary Break
Foam board keeps warm, humid summer air from cold concrete – prevents condensation
Crawlspace guidance

Make the crawlspace part of the inside

• Keep water out
  - use perimeter drainage to keep out rainwater and ground water
  - use a vapor barrier to prevent water vapor entry from the soil
  - repair plumbing leaks
• If crawlspace is dry - seal vents
• In cold climates insulate the crawlspace walls
• Exhaust air from beneath groundcover to prevent entry of soil air laden with radon or other contaminants
Make the crawlspace part of the outside and really vent it
And don’t spray the building...
Plumbing
- No plumbing in insulated walls or ceilings
- Provide access to plumbing
- Test supplies, drains, appliances and fixtures
Condensation on cold water line insulation
Condensation - humidity and chilled surfaces
Humidified Buildings Cold Climates
Safe humidification?
Condensation in the enclosure - cold outside