Building Science Syllabus

Sunday Evening: Introductions

- Welcome, overview of class,
- Brief discussion: what do you want to learn? What has been your experience? What are your goals?

Monday AM: Context/BS 101

- What is Building Science (BS)?
- Identify major topics of BS: heat, moisture, structure, acoustics, fire, combustion
- History of BS
- BS today: practical application, organizations, resources
- Thermodynamics 101:
    - Three forms of heat transfer (featuring classroom demos)
    - Sensible vs. Latent Heat
    - Examples in the built environment

Monday PM: BS 101

- Thermodynamics Continued
- Hygrodynamics 101:
    - Three basic phases of water and its properties
    - How water moves (featuring classroom demos)
    - Hygro properties of building materials

- Hygrothermal Dynamics: How heat and water work together
    - Moisture transport/drive
    - Drying potential
    - Latent heat of moisture

- The Physics of Comfort

Homework: find one example each of hygrothermal dynamics in natural ecosystem, built environment, other industry or context

Tuesday AM: Applied Science in the Building: The Shell

- Components of the shell:
    - basements
    - walls
    - roofs

- Material types and their jobs, ratings, and evaluations (i.e. insulation, R-value, ASTM rating, inverse of conductance)
    - Heat:
        - Insulation
        - Mass
        - Windows and Doors
        - Air barriers
    - Moisture:
        - Vapor barriers
        - Weather-resistant barriers
        - Flashing
        - Drainage planes
        - Cladding/roofing

Tuesday PM: Applied Science in the Building: The Shell (cont.)

Envelope Theory and Detailing
- Thermal Envelopes/Boundaries
    - defining the envelope
    - components: insulation and air barrier
    - requirements:
        - conductive/radiant loss
        - convective loss
        - cooling
        - vapor loading
        - liquid moisture
- Issues - Heat:
    - Thermal bridging
    - Air bypasses
    - Overheating and cooling
    - Old vs. new construction strategies
- Moisture and the envelope:
    - Condensation
    - Precipitation
    - Other leaks
    - Old vs. new construction strategies

- Field trip to building to perform infrared thermography and blower-door test to illustrate functioning of building systems

Homework: Draw one foundation-to-wall or wall-to-roof detail of your choice, identifying thermal and moisture control systems and their connections

Wednesday AM: The Building as a Whole System

- Interconnection of envelope, mechanical systems, layout, use patterns
- Renovation: a history of mistakes
- New construction: troubleshooting high-performance building strategies
- Systems of the building:
    - heating

Wednesday PM: Systems of the Building (cont.)

    - cooling
    - ventilation
    - DHW
    - Electricity
- Other gains - maximizing and minimizing:
    - Solar gain
    - Internal gains: lighting, plug loads
- Tours of system types
    - combustion testing
    - IR scanning of heating systems
    - ventilation system eval/exhaust fan testing

Homework: Design the mechanical schematics for a model building

Thursday AM: Designing with Science

- Start with the site
    - climate (rainfall, HDD/CDD, insolation)
        - challenge: find all relevant climate data for your location
    - sun
    - wind/exposure
    - regulations and local ordinances
- Invest in the envelope
    - shape
    - orientation
    - profile
    - construction
    - upfront vs long-term costs
- Consider mechanicals
    - appropriate sizing
    - fuel types
    - water systems
    - air and ventilation
    - upfront vs long-term costs

Thursday PM: Predicting and Prescribing Performance

- Modeling for heat loss/energy load
- Determining ventilation requirements
- Specifying DHW loads
- Ecological science and building performance

Homework: Begin final design project - design a high-performance new building, or performance retrofit of existing project of your choice, including basic shell and mechanical specification in response to specific climatic and site-based circumstances.

Friday AM: Studio - Final Project

Friday PM: Present Final Project