Beyond Textbooks – Benefits and Challenges of Teaching from Handbooks, Standards, and Other Professional Resources

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My Pertinent History

• Education – Mechanical Engineering
• USACE researcher 1980s
• Consulting engineer, full time 1989 - 1994
• Teaching since 1994
  – Architectural Engineering faculty
  – Professional development instructor
• Global scientific and technical society activities – mainly ASHRAE
Observation #1

• You can’t teach building sciences to students you don’t have – most engineers in my area start with general purpose ME educations...so professional development programs, professional masters programs are critically important
Observation #2

We don’t know who discovered water, but we’re pretty sure it wasn’t a fish.

• For those who choose their path early, Architectural Engineering schools have provided building science education since before building sciences had a name.
Penn State AE Curriculum

• Undergraduate
  – Four options: Structures, Mechanical, Lighting/Electrical, Construction Management
  – Core (years 1-3) all option areas + architecture + materials + graphics/working drawings + acoustics + plumbing and fire protection + building industry
  – Specialization (years 4-5) student choice option
  – Full year integrative capstone project with depth and integrated breadth
Penn State AE Curriculum

• Required courses include
  – Air and moisture transfer fundamentals
  – Daylighting principles
  – Thermal modeling of whole building

• Explicitly building science focused electives
  – Building Enclosure Science and Design
  – Building Performance Failures and Forensic Techniques

• Future building enclosure MS?
Penn State AE - Enrichment

- Student professional and technical organizations – specialties and AEI
- Design competitions – AEI, ASHRAE, DOE...
- Study abroad – Italy, China
- Internships
Observation #3

• The most valuable resource for building science education is the instructor
  – Select resources
  – Create resources if necessary
  – Interprets resources for the target learner
  – Structures the learning experience to achieve objectives
  – Draw the line between “education” and “training” – particularly w.r.t. software use
Textbooks

• When available, provide
  – Structured exposition of a field
  – Examples and exercises to develop and test knowledge

• Most effective for
  – Settled scientific fundamentals
  – Relatively narrow fields

• Not well-suited to most advanced courses...in my experience
Potential Alternative Resources

- ASHRAE
  - Handbooks (standard of care)
  - Standards/Guidelines (standard of care)
  - Design Guides (best practices)
  - ASHRAE Journal (peer-reviewed, practice-oriented)
  - High Performance Buildings (case studies, general technical audience)
- Research papers (findings/methods)
- Manufacturer literature (subtle/not subtle bias)
- Trade magazine articles (practice-oriented, not peer-reviewed)
- Software tools (after learning what’s inside!)
Air Leakage and Pressurization

- ASHRAE 2013 Fundamentals
  - Ventilation and Infiltration
- ASHRAE 119 Air Leakage Performance for Detached Single Family Residential Buildings
- ASTM 779 Standard Test Method for Determining Air Leakage Rate by Fan Pressurization
- ASHRAE Guideline 16-2010 Selecting Outdoor, Return, and Relief Dampers for Air-Side Economizer Systems
Air Leakage and Pressurization

- Persily – Myths About Building Envelopes (ASHRAE Journal)
- Bahnfleth, Yuill, Lee - Protocol for Field Testing of Tall Buildings to Determine Envelope Air Leakage Rate
- Blower door test data analysis
- CONTAM modeling
Challenges/Opportunities

- Adapting material from its target audience to your target learner
- Expanding on concise presentations in handbooks
- Teaching principles behind standards and guidelines
- Identifying critical skills to detect potential errors and bias
- Continuous updating needed
Final Thoughts

• Building science is broad, specialties are deep, time is limited for students and professionals – so customization is critical

• Many textbooks have limited value – too shallow, too narrow, wrong perspective

• Enormous amounts of current information is available, but must be selected and interpreted for audience – education of educator is the key