"Not So Difficult" Approaches for Building Science Education

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- ASTM
- JCBSE

Driving Goal

- To improve building science education
  - Quantity
  - Quality
- In degree programs for building professionals
  - Associate
  - Undergraduate
  - Professional
  - Graduate

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Desired Outcome

- To ensure all students in building design, engineering, construction, and operations will graduate with:
  - a substantive “building science fundamentals” course early in their program,
  - solid “building science” concepts infused into their traditional courses, and
  - access to specialized, in-depth building science coursework.

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Mission of Joint Committee for Building Science Education

- Support transformation of the education and training of the design and construction industry, such that its professionals:
  - Are educated, trained, and certified in building science and related advanced design and construction management practices;
  - Can routinely design, build (renovate and fix), and operate quality, high performance buildings that are safe, healthy, durable, comfortable and very energy efficient; and
  - Will provide the highest value to their clients.

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Background

- Toronto (ASTM/NIBS/JCBSE) Workshop and previous DOE & HUD workshops identified:
  - Strong interest in building science education,
  - Good examples of current building science programs,
  - Solid existing building science teaching resources, but
  - Substantive academia constraints and challenges.
- Subsequent focus on potential solutions:
  - Move from addition to integration,
  - Move from stand alone to infusion,
  - Move from “easy button” to “not so difficult”.

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Important Themes

- Using a broad definition for "building sciences".
- Focus => Building science KSA's needed to plan, design, analyze, construct/renovate, and commission quality, high-performance buildings.
- Priority => Health, Safety, Durability, IAQ
  - First: Ensure no harm and no lawsuits;
  - Everything else (including daylighting, passive, green, sustainability) is second to, and/or must fit under this overarching priority.

Note: Core competencies for A/E Firm New Hires and DOE BSE Guidelines are available as handouts on table.

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Pathways for Success

- Support infusion of building science into traditional coursework and teaching resources,
- Promote a dedicated building science fundamentals course, and
- Encourage special higher level building science technical electives.

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Pathways for Success

- Provide easy access to building science resources
  - Promote excellence in building science teaching texts and support materials.
- Ensure best practices
  - Up-to-date access to research results
  - Connection to real world applications.
- Support graduate building science programs to increase future teaching capacity.
- Support & Expand building science experiential learning (RTZ) & pair to academic learning

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Great Progress (Post-Toronto)

- Affirming opportunities for "infusion"
  - Traditional courses; associated teaching resources
- Quality resources for teaching building science
  - Currently available or under development
- Improved access to building science research & best practices
  - DOE Building America Solution Center
  - Other: ASHRAE, NIBS, BSC, BSL, Joint Committee
- Excellent Experiential Learning Opportunities
  - Race to Zero, etc.

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Prioritization of Building Science

Key Assumptions

- Priority building science requirements
  - Health & safety, building durability, IAQ
- Priority damage functions (buildings & people)
  - Fire, smoke, and structure
    - critical, but addressed by codes and established practice
  - Moisture Management (Water, Water, and Water)!
    - critical, but currently underrepresented
  - Indoor Environmental Quality
- Effectively dealing with damage functions
  - risk tolerant designs and work procedures (e.g., QM)

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Conveying Key Building Science Concepts
Heat & Mass Transfer/Moisture Transport/IAQ

- Can critical concepts be fit into existing courses?
  - Heat transfer, 2nd Law of Thermodynamics (simplified)
  - Psychrometrics, relative humidity (RH), dew point
  - Prioritized moisture transport mechanisms
  - Requirements for air flow
  - Functions of the enclosure; esp. environmental separation
  - Continuity of control layers; verification with pen test
  - Understanding hygrothermal performance of enclosures, including performance consequences of material/placement
  - HVAC systems; esp. ventilation and make-up air
- Within one or two modules is a huge challenge?
  - Currently a “work in progress”, but has been done!

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Building Science Resources
(Partial Listing)

- Key Textbooks/References
  - ASHRAE Handbook of Fundamentals
  - High Performance Enclosures: Straube, J.
  - Understanding Psychrometrics: Gatley, D.
  - Water in Buildings: Rose, W.
  - Currently under development
    - Building Science Fundamentals: Lstiburek, J.
    - Building Science for Building Enclosures: Straube, J. & Burnett, E. 2nd Edition

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Building Science Resources
(Partial Listing)

- Online Resources
  - DOE Building America Solution Center
    - https://basc.pnnl.gov/
  - Building Science Corporation
    - www.BuildingScience.com/Information
  - Building Science Labs
    - www.buildingsciencelabs.com/the-library/
  - Joint Committee Website
    - www.BuildingScienceEducation.net
  - SBSE Website
    - www.sbse.org/resources/

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Building Science Infusion & Fundamentals (Research Underway)

- Step 1: Identify Traditional Target Courses
  - Obtain syllabi from leading schools
  - Identify required & recommended textbooks
  - Identify supplemental teaching materials
  - Review for gaps in key building science topics
  - Identify possible approaches to convey key concepts
  - Initial test of infusion approaches (work in progress)

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Building Science Infusion & Fundamentals (Research Underway)

- Step 2: Review Teaching Materials for Courses
  - Work with key publishers to obtain identified texts
    - Wiley
    - Pearson/Prentiss Hall
    - ASHRAE
  - Review textbooks for treatment of critical building science topics
  - Review textbooks and online resources for supplemental building science materials

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Building Science Infusion & Fundamentals (Research Underway)

- Step 3: Support Modification to Courses & Texts
  - Work with publishers and authors to identify process/ timelines for updating text or supplemental materials
  - Work with authors of building science resources
    - within texts, articles, supplemental materials
    - identify gaps that need to be filled by new resources
  - Need to integrate "best treatment" of key concepts into traditional modules (or for adding new modules)

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Building Science Infusion & Fundamentals (Research Underway)

- Step 4: Process to Enhance Traditional Resources
  - Peer review of common textbooks
    - identify opportunities for enhancements, clarifications, corrections, etc.
  - More frequent printings of textbooks
    - opportunity for building science supplements
  - Update/expand online supplemental material
  - Publish peer-reviewed supplements on the JCBSE website

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Priority Targets for Building Science Infusion

- Environmental Controls/Systems I & II
  - Typically touches on heat transfer and air flow
  - Generally includes discussion of RH & IAQ
  - Popular references/texts include:
    - Mechanical & Electrical Equipment for Builings: Grondzik, W., Kwok, A., Stein, B., Reynolds, J.
    - Heating, Cooling, Lighting: Sustainable Design Methods for Architects: Lechner, N.

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Priority Targets for Building Science Infusion

- Materials & Methods I & II (aka Construction Technologies I & II)
  - Typically touches on enclosure design
  - Can include discussion of moisture, RH
  - Popular references/texts include:
    - Building Construction: Mehta, M.
    - Building Construction Illustrated: Ching, F.
    - Fundamentals of Building Construction: Allen, E., Iano, J.

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Priority Targets for Building Science Infusion

- Other Potential Course Targets
  - Construction Documentation
  - Construction Project Management
  - Systems Integration/Synthesis
  - Sustainable Design

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Building Science Fundamentals

Dedicated Stand Alone Course

- Requirement or technical elective
- Provides adequate coverage of key concepts & principles
  - Heat & mass transfer
  - Hygrothermal performance of enclosures
  - HVAC, IAQ, etc.
- Variations have been taught at:
  - U-MN, U-IL, Waterloo, Penn State, Leuven, etc.
- Popular textbooks & resources
  - High Performance Enclosures
  - ASHRAE Handbook of Fundamentals
  - Building Science for Building Enclosures
  - Online Articles: BSC, BSL, BA Solution Center, etc.

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Building Science Fundamentals

U-MN "Hygrothermal" Experience

- Establish Context, Perspective, and Principles
  - Lstiburek: "5 Fundamental Changes"
- Module 1: Heat Transfer
  - Assumes prerequisite modules (incl. labs) on heat transfer, psychrometrics, etc.
  - Temperature profile (hand calcs/spreadsheet)
- Module 2: Moisture Transport
  - Enhanced Glaser (Dew Point) Method (spreadsheet)
- Module 3: Material Storage
  - 1-D coupled heat & moisture analysis (WUFI software)

Note: This approach was successfully applied by RTZ team.

DOE Race to Zero

Building Science Experiential Learning

- To date, 54 schools, 100 teams, and several hundred students and faculty have participated
  - Each RTZ team has participated in a mandatory "Building Science Fundamentals" training session.
  - All designs must meet DOE ZERH requirements.
  - Homes that are so efficient a small renewable system can offset all or most energy needs.
- Subscribe your "potential interest" for 2017 RTZ
  - Review the benefits
  - Access to key resources

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Expanding Building Science Experiential Learning

- Imagine the Impact
  - If the RTZ building science resources were available for the other student competitions.
  - Shouldn't their designs reflect this level of building science and best practices?

- Next Penn State will address "**Building Science Education as an Integral Part of Project-Based/ Experiential Learning**"

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Good News

- Significant progress is being made towards larger building science education goals and outcomes.
- Several short-term successes:
  - Demonstrated that it is “not so difficult” to infuse building science into existing courses,
  - Uncovered a wealth of building science teaching resources that are (or will be) readily available,
  - Several experiential learning opportunities to reinforce building science best practices.

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Our Challenge

- Short-Term Objectives
  - Continue to support “building science infusion”
  - Increase, peer review, improve, share building science resources (need qualified peer reviewers)
  - Expand experiential learning opportunities
- Medium-Term Targets
  - Push for revision of curriculum, credentials, accreditation, etc. to incorporate building science
- Long-Term Goals
  - Support graduate education and research in building science, so we will have great teachers and mentors

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Thank You

- Be sure to visit the JCBSE website
  - www. BuildingScienceEducation.net
- Contact information
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DOE Race to Zero

Key Benefits (video)

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