



2016 WESTFORD UPDATE ON BUILDING SCIENCE EDUCATION

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Joint Committee on Building Science Education

<http://www.BuildingScienceEducation.net>

July 31, 2016



AGENDA

- **Introductions & Brief Update**
- **Preview of the new DOE/PNNL Building Science Education Solution Center – Sam Rashkin, Cheryn Metzger;**
- **Discussion on new and planned resources (textbooks, references, etc.) – Joe Lstiburek, Pat Huelman, others [Note: Please contribute input on citations and brief description of resources.]**
- **Development of a new “*hygrothermal analysis guide*” to support RTZ faculty and students; and modules for traditional courses**
- **Progress on infusion of BSE into traditional courses for future design professionals – Sam Taylor**
- **Discussion: Prioritized Elements of Benchmark for quality, high performance buildings & homes**



THE BIG PICTURE

➤ Long-term Goal

- To increase the quantity/quality of building science education
- In support of high-performance buildings

➤ Short-term Goal

- Identify solid building science resources that can support:

DOE Student Competitions

Race to Zero

Solar Decathlon

Better Buildings

High-Performance Building Programs

Zero Energy Ready Homes, Better Buildings, ENERGY STAR,
PassiveHouse, LEED for Homes, etc.



THE BIG PICTURE

- The current “desired outcome” is to ensure all students in building design, engineering, construction, and operations will have:
 - 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



OUTREACH ON BUILDING SCIENCE RESOURCES

- **Westford 2015**
- EEBA – Denver, CO
- NIBS/ASTM/JCBSE BSE Workshop, Jan. 2016, Arlington, VA
- ASHRAE, Orlando
- NAHB-IBS, NCHRC, Las Vegas
- Penn State Residential Conf. - BSE Session, March 2016
- DOE Peer Review, Falls Church, VA
- 3rd DOE Race to Zero Student Design Competition, Golden
- Joint WebEx Working Meetings – Hygrothermal Analysis Guide
- AHSRAE, St. Louis, MO
- **Westford 2016**



NIBS/ASTM/JCBSE BSE WORKSHOP



Solutions for Building Science Education – Jan. 11, 2016

Westford Building Science Education UPDATE – July 31, 2016
Joint Committee on Building Science Education | NIBS/BETEC Ed.Com.



2016 NIBS/ASTM/JCBSE WORKSHOP ON BUILDING SCIENCE EDUCATION

- **Workshop Reflected Broad, High-Level Support**
 - Keynote addresses from industry & academic leaders
 - Leadership of AIA, ASHRAE, ASC, SBSE, etc.
- **Presentations Focused on Solutions**
 - **Sharing pedagogical approaches**
 - ✓ Infusion of building science principles
 - ✓ Building science fundamentals and beyond
 - ✓ Pairing of academic & experiential learning
 - **Current state of building science resources**
 - ✓ Textbooks, supplemental materials
 - ✓ Need for best current science



PENN STATE RESIDENTIAL CONFERENCE - MARCH 2016 BUILDING SCIENCE EDUCATION SESSION



Joint Committee Presentation: “Not So Difficult” Approaches to Improve Building Science Education in Collegiate Design & Construction Programs



IMPORTANT THEMES OF BSE SESSION

- 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) is second to and must fit within this overarching priority.

NOTE: This prioritization also important for benchmarking criteria for “quality, high performance buildings/homes”



PRIORITIZATION OF BUILDING SCIENCE

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



CONVEYING KEY BUILDING SCIENCE CONCEPTS

- **Can these 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 it has been done!



BUILDING SCIENCE FUNDAMENTALS

U MN “HYGROTHERMAL” EXPERIENCE

- **Establish Context, Perspective, and Principles**
- **Heat Transfer & Thermal Profiles**
- **Psychrometrics, Moisture Transport & Vapor Profiles**
- **Material Storage & Modeling**
- **Wrap-up & Analysis**

Note: This approach has been part of our senior capstone course for many years and successfully applied by our U of MN RTZ teams.



FUTURE EVENTS / NEXT STEPS

- Continue Joint Webinars – Task Group/WG
 - Building Science Education Resources –
 - ✓ Hygrothermal Analysis Guide
 - ✓ Modules for Traditional Courses
 - Infusion of Building Science in Traditional Courses
- EEBA/DOE Task Force – Dallas, TX; September 2016
- BUILDINGS XIII – Clearwater, FL; Dec. 6 BSE Update
- DOE Race to Zero Student Competition – Golden, April 2017



2015 RACE TO ZERO





RACE TO ZERO STUDENT DESIGN COMPETITION

2016 Race to Zero

- Review 2016 RTZ results (posted on DOE & BSE Web)
- 25 Universities; 31 Teams; Over 300 Students

2017 Race to Zero

- **NOW**, Multi-Discipline Team Formation –Including Industry Support (Advisors/Mentors, etc.)
- June 30, 2016 – Formal Start – The Race Begins
 - Revised Competition Guideline Released
 - Registration Opened: Registration of Interest, or Team Registration
 - July 2016 to February 2017 - Webinars and building science training available
- November 1, 2016 – **Registration Deadline**
- Feb. 28, 2017 – Project Progress Report Deadline
- Project Report Submission Deadline – April 4, 2017
- Judging & Awards Event – Golden, CO – April 22-23, 2017

- Contact racetozero@ee.doe.gov



RACE TO ZERO STUDENT DESIGN COMPETITION

- Over the last 3 years, the DOE Race to Zero (RTZ) Student Design Competition has provided 54 schools, 100 teams, and several hundred students/faculty with a building science experiential learning opportunity that is supporting the transformation building science education in universities and colleges.

- Where will the “easy to adapt resources and approaches” be found?
 - To support RTZ and other experiential learning opportunities
 - To pair experiential & academic learning
 - To build comprehensive university building science programs

- Contact racetozero@ee.doe.gov



PREVIEW OF DOE/PNNL BSE SYMPOSIUM CAMEO

A FEW HIGHLIGHTS --

- DOE BSE Guidelines & BSE Solution Center
- DOE Race to Zero
- More



CURRENT DOE BSE EFFORTS

Step 1: Use the [Guidelines for BSE](#) matrix to inform the development of a Building Science Education (BSE) Solution Center

Step 2: Develop new [BSE Solution Center](#) by using existing (or develop new) training modules

Step 3: Develop and promote partners who provide content for and use either the [Guidelines for BSE](#) or the [BSE Solution Center](#), using the “*Collective Impact*” model

Step 1: Use The Matrix as a Foundation

	1. High School Education	2. Builders/Remodelers	3. Builders (owner/managers)	4. Builders (foreman)	5. Remodelers (foreman)	6. Remodelers (owner/managers)	7. Insulation Contractors	8. HVAC Contractors	9. Enclosure Contractors	10. Plumbers	11. Home Performance	12. Program
1. Integration of the Whole-Building System												
a. Performance (energy, durability, comfort, etc.)	1	4	5	4	5	5	5	5	4	4		3
b. Life cycle cost-effectiveness analysis	2	5	5	5	5	4	4	4	4	4		2
c. Disaster resistance/resiliency	2	3	4	3	4	4	2	5	3	4		3
d. Integrated design and construction	2	4	5	4	4	3	4	4	3	4		2
e. Quality management	2	5	6	5	6	6	6	6	6	5		4
f. Building and energy modeling	2	2	3	2	3	3	4	3	2	4		3
g. Cost trade-off analysis	2	4	5	4	5	4	4	4	4	5		3
2. Building Science Principles												
a. Heat transfer (conduction, radiation, convection)	1	2	3	2	3	5	4	4	2	4		3
b. Moisture transport (liquid, vapor, psychrometrics)	1	3	4	3	4	4	4	4	2	4		3
c. Convective mass (air) transport (pressure/flow)	1	3	4	3	4	4	4	3	3	4		3
d. Material selection (IAQ, thermal mass, moisture)	1	2	3	2	3	4	2	4	2	4		3
e. Control layers (water, air, vapor, thermal, sound)	1	4	5	4	5	5	4	5	2	4		3
f. Hygrothermal analysis	1	2	3	2	3	4	2	3	2	4		1
g. HVAC Systems (heating, cooling, ventilation)	2	3	4	3	4	3	5	3	3	4		4
h. HVAC interactions with enclosure	2	3	4	3	4	3	5	3	3	4		3
i. Fenestration	2	2	3	2	3	3	4	4	2	4		3
j. Plumbing systems (heating, distribution, cooling)	2	3	4	3	4	2	3	3	5	4		3
k. Electrical systems	2	2	2	2	3	2	3	3	2	3		3
l. Lighting, appliances & misc. loads	2	2	3	2	3	2	3	2	3	4		4
m. Indoor environmental quality (thermal comfort, air quality)	2	3	4	3	4	4	5	3	3	4		4
n. Control/Automation systems	2	3	4	3	4	2	5	3	2	4		3
3. Operations and Maintenance												
a. User interface and controls	3	4	5	4	5	4	2	5	3	2		2
b. Preventative maintenance	3	2	3	2	3	2	4	4	3	4		2
c. Replacement & renovation	2	3	4	3	4	5	3	5	5	4		3

Step 2: All-Inclusive Training Modules for Professors and Other Trainers

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FIND YOUR TOPIC BY:

Job Classification
Building Science Topic

FIND PARTNERS BY:

Interactive Map
Job Classification

FIND RESOURCES

Video Directory
Case Studies
Free Reading Material

HVAC Interactions with the Enclosure – Level 3

Intro text describing the module and why it is important.

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Learning Objectives

Materials

Practice Problems

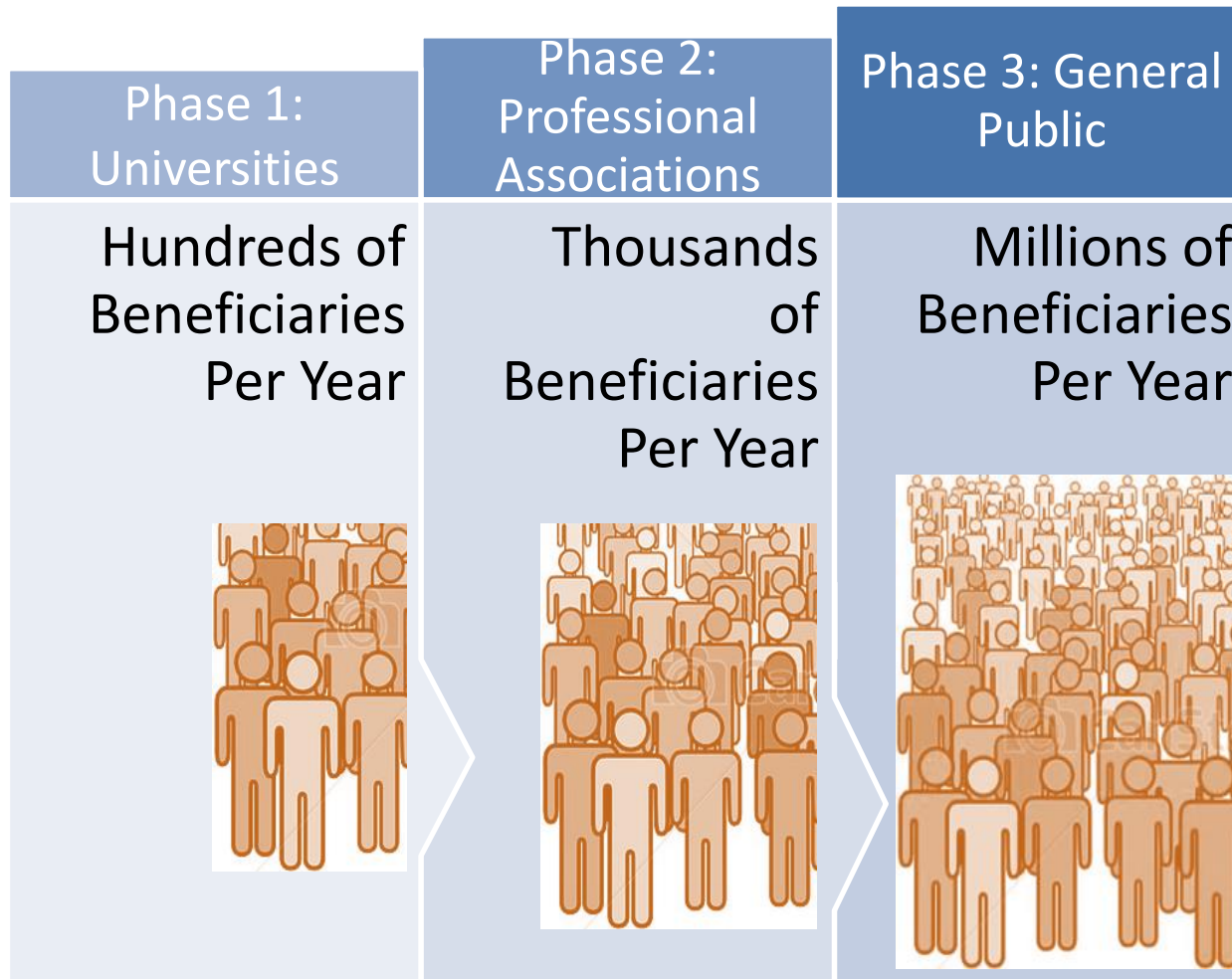
Assessment Questions

Materials page includes links to:

- [Lecture notes](#)
- [Demonstrations and experiments](#)
- [Handouts](#)

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Step 3: Partnerships for Collective Impact



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RESOURCES: BUILDING SCIENCE EDUCATION

On-line Databases/Resources (*partial listing*)

- www.BuildingScienceEducation.net/Resources
- www.BuildingScience.com/Information
- www.buildingsciencelabs.com/the-library/ & /presentations/
- <https://basc.pnnl.gov/> (new university solution center section)
- www.sbse.org/resources/ - educators resource under development
- <http://constructioninstruction.com/> (see videos)

Textbooks & Associated Resources (*New or Under Development*)



BUILDING SCIENCE EDUCATION RESOURCES

- **Building Science Fundamentals, Joe Lstiburek**
- **Construction Instruction, Mark LaLiberte**
- **Peter Yost, Green Builder**
- **BETEC /BEC Education -**
- **More: Passive House NA, etc.**



BRIEF RECAP – INFUSION OF BUILDING SCIENCE

Infusion of Building Science into Traditional Courses (*see Webpage*)

- Longer Term – Key Textbooks/References
 - Infusion of building science best practices into textbooks & associated supporting materials (slides, etc.)
 - Identify & engage authors and reviewers
- Near Term – Improve Traditional Courses -
 - Review curricula, texts, slides
 - Provide best practice errata (slides/handouts) to counter bad practices and misleading resources
 - Introduce “why” of best building science practices
- **Please Identify and Share**
 - Recommended Target Courses for Infusion
 - Recommended Modules/Other Resources
- Note Online BSC and BSL resources



PRIORITY TARGETS FOR INFUSION OF BUILDING SCIENCE

➤ 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 Buildings: Grondzik, W., Kwok, A., Stein, B., Reynolds, J.
 - ✓ Heating, Cooling, Lighting: Sustainable Design Methods for Architects: Lechner, N.



PRIORITY TARGETS FOR INFUSION OF BUILDING SCIENCE

- **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.



PRIORITY TARGETS FOR INFUSION OF BUILDING SCIENCE

➤ Other Potential Course Targets

- Construction Documentation
- Project Management
- Sustainable Design



BUILDING SCIENCE FUNDAMENTALS & INFUSION

Open Discussion

Facilitated by: Pat Huelman, Sam Taylor & tbd



Help Build Our Knowledge Base

(see Webinar Webpage)

- **What courses might be adapted for a comprehensive building science fundamentals course?**
- **What courses do you recommend for initial infusion?**
- **What textbooks and other resources are required or recommended for these courses?**
- **Do the course slides and reading assignments represent best practices?**
 - **Provide examples of problem content in such resources, along with suggested corrected slides, errata handouts, etc.**
 - **Expose students to details showing best building science practices.**
 - **Share approaches for infusing the “why” such details represent best practices**




CONTINUATION OF WEBINAR SERIES

- **Initial Webinars**
 - Identified, reviewed, shared resources for a Building Science Fundamentals course;
 - Infusion of Building Science into traditional courses (resources and methodologies); and
 - proposed addressing Specialized Courses, e.g., Building Science for Building Enclosures, Building Forensics, Commissioning, etc.

- **Continuing to Develop “not so difficult” steps to begin or expand and improve building science education**

- **Current Efforts – WebEx facilitated expert working groups**
 - Hygrothermal Analysis Guide for RTZ faculty & students
 - Supplemental modules for early target for infusion

www.BuildingScienceEducation.net/Events/WEBINARS



EXCELLENCE IN BUILDING SCIENCE EDUCATION
Transforming the Design/Construction Profession

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Building Science WEBINARS

These Webinars are co-hosted by the [NIBS/BETEC Education Committee](#) and the [Joint Committee on Building Science Education](#).

Objectives/Background for the Current Series of Webinars:

- Webinar Series to Fulfill Needs Addressed in [Toronto BSE Workshop](#)
 - Infusion of Building Science into Traditional Courses (resources and methodologies);
 - Identify, Review & Share Resources for a Building Science Fundamentals course
 - And, as time permits, address Specialized Courses, e.g., Building Science for Building Enclosures, Building Forensics, Commissioning, etc.
- Develop "Easy" Steps to Begin or Expand & Improve Building Science Education – In Spite of University Constraints
- Share Results on Committee Website
- Facilitate Infusion of Best Building Science Practices in Teaching Resources for Traditional Courses – through
 - Authors and Reviewers of Textbooks and Key References
 - Development of modules and handouts for target Traditional Courses

Building Science Education Webinars

April 2, 2015 Webinar - Emphasis of the webinar was infusion of building science best practices into traditional courses (curriculum and teaching resources). VA Tech provided the WebEX resources.

- [April 2nd Slides](#)
- [WebEx Recording of the meeting.](#)

May 5, 2015 Webinar - See [WebEx Information & Tentative Agenda](#)

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POSSIBLE SIDE DISCUSSIONS AT WESTFORD

- **Definition of quality, high-performance buildings (and homes)**
 - **Buildings using Congressional definition**
 - **Homes have used Zero Energy Ready Home Specs (Builders Challenge)**
 - **Is there a better definition for homes that parallels the Congressional definition?**

- **Provide recommendations for target courses and resources for infusion**



**THANKS FOR PARTICIPATING
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BUILDING SCIENCE EDUCATION UPDATE**