Task Group: Criteria on Excellence in Building Science Education Curricula

Task Group: Following the 2012 Annual Meeting of the University Consortium, a task group was formed to develop the criteria for excellence in building science education curricula. Current leaders of the task group include:

- Pat Huelman (Chairman) - University of Minnesota
- John Straube (Co-chairman) - University of Waterloo

Development of Criteria Metric: Criteria for excellence in building science education curricula and associated content are being developed to define, and set the expectations for, building science education. The criteria will provide a metric against which universities; accrediting organizations and licensing and certification programs can assess building science curricula, key courses, teaching methodologies, and learning outcomes. The criteria will help guide the development of such teaching materials. Also, it will support the annual award for "excellence in building science education" and support student competition programs for quality, high performance homes.

"Building science" is broadly defined, for the purposes of the Task Group, to include the building science and technologies, and advanced design and construction management practices required to routinely plan, design, analyze and build quality, high performance homes that durable, safe, healthy, comfortable and very energy efficient. The Task Group also adopts a requirement for a "quality, high performance home that is very energy efficient" as meeting or exceeding the requirements of the DOE Challenge Home. Further, the Task Group recognizes that the student's business model requires proficiency in the design and construction of both residential and commercial buildings, and that housing ranges from small, single family homes to large, multifamily structures which could include retail and office space.

The criteria will address the following areas:

- building science curricula;
- key courses and teaching methodologies, and
- requirements for acquired knowledge, skills and abilities (KSA's).

The initial focus of the criteria is university level courses. A matrix of curricula is being developed against different disciplines supporting the design/construction industry:

- Engineering (e.g., Mechanical, Civil, Architectural);
- Architecture (skilled in building performance);
- Construction Management; and
- Other (Material Science, Building Physics (EU)).

The Criteria might include:

- Education that supports the expansion of a certified, professional workforce that routinely designs and builds quality, high performance homes that are healthy, safe, durable, comfortable, and energy efficient.
- Curriculum that addresses both *specialized courses* in building science and building performance along with *standard courses* which integrate advances in building science and quality management, e.g., construction management, construction documentation, etc.
- Technical basis for the curriculum is traceable to currently accepted, peer-reviewed research.
- Possible recommended curricula should address:

- Building science for building enclosures
  - Optimization across various building performance parameters, including trade-offs for fire, moisture, constructability, strength, cost, etc.
  - Hygrothermal analysis for building enclosures
  - Characterization and performance of building materials, components, and assemblies
- HVAC system performance
  - Whole building mechanical system analysis (including loads, flows, and pressures)
  - Advanced ventilation
  - Fundamentals of indoor environmental quality, including pollutant sources
  - Heating and cooling load analysis (ASRHAE, ACCA, etc.)
  - Installed performance of equipment and systems (dehumidification performance, part load efficiency, diagnostics and sensors, etc.)
- Construction Management
  - Critical path analysis and process control
  - Advanced quality management principles (see ToolBase, etc.)
- Design/Construction Documentation (advanced detailing, quality scopes of work, etc.)
- Design Process (Integrated Design Process, Codes & Beyond Codes, etc.)
- Building Performance Analysis and Documentation
  - Diagnostics
  - Commissioning
- Systems Engineering

Requirements for Acquired Skills (e.g., KSA's)

The University Consortium, and our partners in the US Department of Energy and other university organizations, envisions a building science certification requirement for design and construction professionals. Currently, there are certification requirements in Canada and Europe. For example, the Ontario Building Envelope Enclosure Council provides a certification for a building science professional (http://obec.on.ca/BSSO/default.asp).

Also, a number of A/E firms have their requirements. Below is an example of one engineering firm's preliminary list of requirements for a building science professional. This particular engineering firm designs, investigates, and rehabilitates structures and building enclosures. Other firms required for different aspect of the planning, design, analysis and building of quality, high performance housing (and commercial and institutional buildings) may have a different set of desired KSA's.

> "For an individual to be prepared for the building science profession, the following skill set is desirable on top of the standard requirements for accreditation and licensure for architects and engineers:
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> - **An understanding and competency in building physics** (heat, air and moisture transfer, including an understanding and ability to evaluate heat flow under each heat transfer mechanism (conduction,
> convection and radiation), an understanding of air flow and moisture-laden and contaminant laden air transportation and understanding of diffusive vapor transportation, and an understanding of wetting and drying mechanisms (i.e. all of the necessary building physics

fundamentals and theory - all building scientists should be capable of relating software results back to first principles)

- **Understanding of psychrometrics** and how to use the chart to understand the HVAC process as well as to determine all of the parameters of importance for building physics from the chart. They must also be able to calculate dewpoint.

- **Ability to run hygrothermal modeling tools** (like WUFI) and heat transfer analysis (THERM, HEAT and HEAT 3-D), and equally as important, translate the results and be able to explain the results as they apply to the real world.

- An understanding of architecture, architectural engineering, structural engineering, building enclosure design, building technology, and other aspects of the other building sciences outside of building physics (lighting and day lighting, acoustics, fire and smoke control, blast and hardening of structures for security measures)

- **Understanding of the four major building enclosure systems** and how they are interrelated and tie-ins between materials and systems for the rainwater management system (waterproofing and flashings), air barrier system, thermal barrier system, and diffusive vapor flow control systems, as well as how building physics relate to these systems.

- **Ability to draw design details** for residential and commercial structures, tie-ins, and explain how each layer of the system is engineered to deal with a certain aspect of building physics, and where the details have to compromise to accommodate the predominant feature needed (say water tightness)

- **Understanding of commercial and residential construction**, including concrete framed, metal framed (structural steel and light-gauge framing) and wood framed structures

- **Understanding of testing equipment/tool**s used on-site to test flow paths or air, water and thermal transfer, including water infiltration testing (spray rack and nozzle), pressure gauges, theatrical smoke, blower doors, temperature and relative humidity gauges and data loggers, and an understanding of how to interpret the results of the tests

- **Understanding of HVAC interaction with the building enclosure**, the enclosures impact on lighting and day lighting choices, and the impact of varying percentages of fenestration.

- **Ability to analyze building performance**, including the ability to run a refined and more accurate energy model, understanding parameters like the effect of adjacent buildings, the effect of space versus occupancy in deciding how much space needs to be conditioned and lit, versus "dead" space, and potential impacts of climate change, all related and tied back into the fundamentals of building physics".