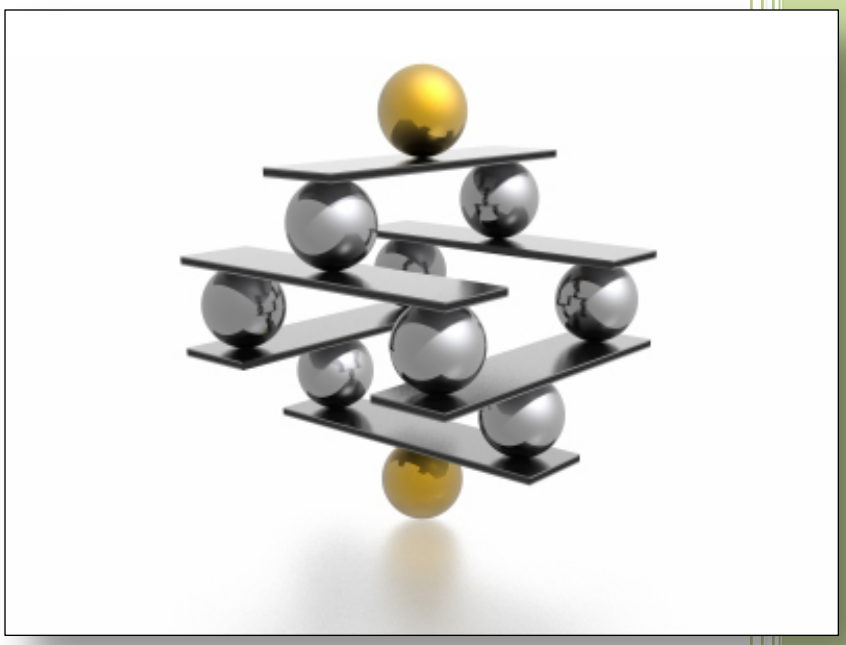
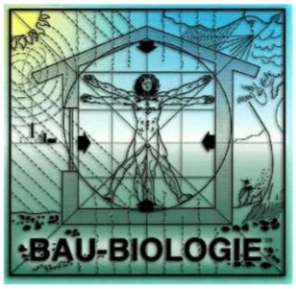
International Institute for Bau-biologie® & Ecology

IBE 202.2

IBE 202.2 Building Science Basics



BRINGING TOGETHER TECHNOLOGY AND DESIGN METHODS TO PROVIDE THE INFORMATION NEEDED TO CREATE HEALTHY HOMES AND WORKPLACES



Building Science Basics – IBE 202.2

Welcome

Thank you for choosing IBE for your educational needs. Current environmental realities demand a new approach to ensuring that our homes, schools and office buildings support the health and wellness of all who dwell there. We strive to provide the latest information and cutting edge methodology on the vital, complex relationship between the natural and the built environments. May you find your educational experiences enlightening, and take this knowledge out into your community for the benefit of all. **Michael Conn**, *Executive Director*, Institute for Bau-Biologie & Ecology.

Course Navigation

You will find that it is very easy to navigate through this course.

- Progress through the lessons using intuitive navigation tools. When you study, make sure to be aware of and use all supporting materials, such as pdf files, video and audio clips, links to other websites or relevant articles or papers, as well as the online forum.
- The last lesson will give you the option of downloading an electronic version (PDF) of the course. Please be aware that this information is copyright protected.
- When finished, you will be ready for the test. These tests are "open book" and are designed to help you evaluate your understanding of the subject.
- When you have finished the entire Course Pack, a Certificate of Completion is available online.

By using the Forum feature, students can share information and solve problems. We would like to see truly interactive discussions take place.

Please be advised that links to third party information may not reflect or support the Building Biology viewpoint. However, it might be of some interest to see how other people, groups, institutions, etc. argue the same subject.

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Lesson 1 – Introduction to Building Science Basics

In order to become a very good building biologist it is first necessary to have a good understanding of building science.

Building science[1] "is the collection of scientific knowledge that focuses on the analysis and control of the physical phenomena affecting buildings." The purpose is to optimize building performance and understand or prevent building failures. Building Science is the study of the transfer of temperature (heat and cold), moisture and air through a building envelope. These phenomena described in building science are scientific fact and must be understood in order to understand how built space "behaves". The solutions that conventional building has applied to this understanding are, from a standpoint of human health and ecology, not optimal. By first understanding these principles we become capable of building properly out of different materials and can understand and explain the scientific principles at play in using alternative methods of construction. Just as an artist regardless of medium, must understand light, proportion, composition and color a building biologist must have a firm grasp of the laws of science that govern buildings, their design, operation and construction. Although the focus of this course is new construction and renovation, it is essential that Building Biologists, who go on to a career other than building design and construction, also understand the physical principles at play within any building envelope in order to diagnose and prescribe the proper cures.

How Building Science Began

Houses since the dawn of humanity have been naturally built. Be they sticks, leaves, rocks or mud, these basic elements have been incorporated and used successfully to house and shelter people throughout time. Errors in design were worked out over generations of craftspeople, and communities who built homes together. They collectively learned from their mistakes and made the changes to ensure the following homes didn't suffer the same deficiencies.

At the turn of the 20th century, homes were mainly wood and brick construction in North America. Hollow walls allowed for moisture to move and dry typically, and airflow throughout was also keeping air exchanges up high. Plaster interior walls modified indoor humidity levels, until wallpaper became popular. Costs to heat these homes were nominal and as such no one cared about the cold and just added more coal or wood to the fire to stay warm. These homes were all built by skilled labor, labor that went through apprenticeships and gained master status within their trades.

World War II ended an economic recession through military spending and the hopes of the business world were that this spending would continue once the war ended. Every serviceman and woman was guaranteed a job and a new home upon returning from the war. This created an unprecedented amount of new housing stock requirement for North America. The need for factories to have product also was a requirement. This led to the industrialization of the housing market. Homes were no longer built by hand using natural or minimally processed materials, but now building materials were being manufactured in the factories to help speed up the building boom. Materials such as drywall and batt insulation rapidly became mainstream items, reducing the need for skilled labor as the installation required less talent and building knowledge. Taping drywall was significantly easier than plastering an entire house. Slowly the older trades people were replaced with those whose knowledge came from the suppliers, and not from fellow builders. This slide down the knowledge slope led to more and more products becoming available to make it easier and easier to build homes, to the point of corporate slogans such as "You can do it, we can help", meaning you no longer need an understanding of how buildings work to build, you just need a credit card.

The second major issue that occurred to change the face of buildings was the oil crisis of the 70's. This was the introduction to the concern that in fact, the costs to heat one's home, could be expensive, and not as cheap as it once had been. This concern led to the energy efficiency mantra of everyone involved in buildings. Start insulating your home and draft proofing, and save some money. This worked and everyone started to make their homes tighter and tighter. Unfortunately there were now effects from their actions. Homes became damp and moldy. People didn't understand exactly what was going on, and the school of building science was created; by engineers, architects, and trades people, to try to figure out what was going on and how to fix it. The academic realms worked hard to calculate heat loss and moisture movement with great success. Cause and effects were determined and discussed at great length. Unfortunately the trades suffered from a lack of knowledge, because they simply learned from the stores, or their untrained superiors, who didn't understand building science either. The social networks on

[1] http://en.wikipedia.org/wiki/Building_science

the job site typically kept the various trades from truly interacting with each other and trying to share knowledge and ideas. The jobsite became more competitive and time was money, thereby not allowing the time to train and learn about the various concepts of building science that were becoming available if one knew where to look. Product manufacturer's could train trades on their products and did so out of a desire to have their product used, not as much as a building science knowledge improvement opportunity. The problem with the whole system is that it simply moved the existing building concept; stick frame construction, forward problems and all, and added band-aid after band-aid to the problem, and never looked at the design as a whole and take into consideration other styles of construction, that worked successfully for centuries.

Building science turned the built environment into various systems, mechanical in nature. Water movement became a mechanism, as did airflow. These were no longer natural systems, but mechanical, that could be rationally calculated and processed, and theoretically defeated through the proper mechanical solution. Occupants are also part of that mechanical system process. Homes became mechanical more and more, requiring less skill to build, less to operate, and more to cost so it seemed. Technology it seems was our salvation with respect to buildings.

Lesson 2 – House As A System

House as a system came about with the evolution of building science. Engineers, architects and building scientists studying the dynamics of buildings discovered that the various elements that they were working with, air, moisture, heat, cool, comfort, ventilation, etc. were surprisingly tied together. Imbalances in one area would have repercussions with respect to other elements of the building. For example: a 1950's leaky 3 bedroom stick frame bungalow with a mid efficiency forced air furnace in the basement is purchased from empty nesters by a family of 5. The first thing they do is upgrade the old furnace to a new high efficiency furnace, and install new windows, replacing the old Anderson sliders. With the cool weather upon them they start to see mould in the house on the windowsills and in the upper corners of the exterior walls. The reasons for failures are multiple in this case. The first is the change of use, from a retired couple that didn't generate a lot of moisture, to a full family with showers and baths and lots of cooking. The old furnace used to take damp basement air in to move through the house and condition, but now the high efficiency furnace takes fresh air from outside so the basement doesn't get as dry as it used to, creating a musty smelling basement. The moisture is kept in the house and condenses on the parts of the wall system that have the least amount of insulation, which is typically exterior upper corners, where the paper wrapped fiberglass insulation has slipped over time, creating a thermal bridge.

This scenario points to the interconnectedness of the occupants, the moisture, the air, and the outside elements, and how all of them operate as a system within the confines of the building envelope. House as a system helped explain these issues and their connectedness, but everything within and without of the building was solely mechanical mechanisms and not biological interactive systems.

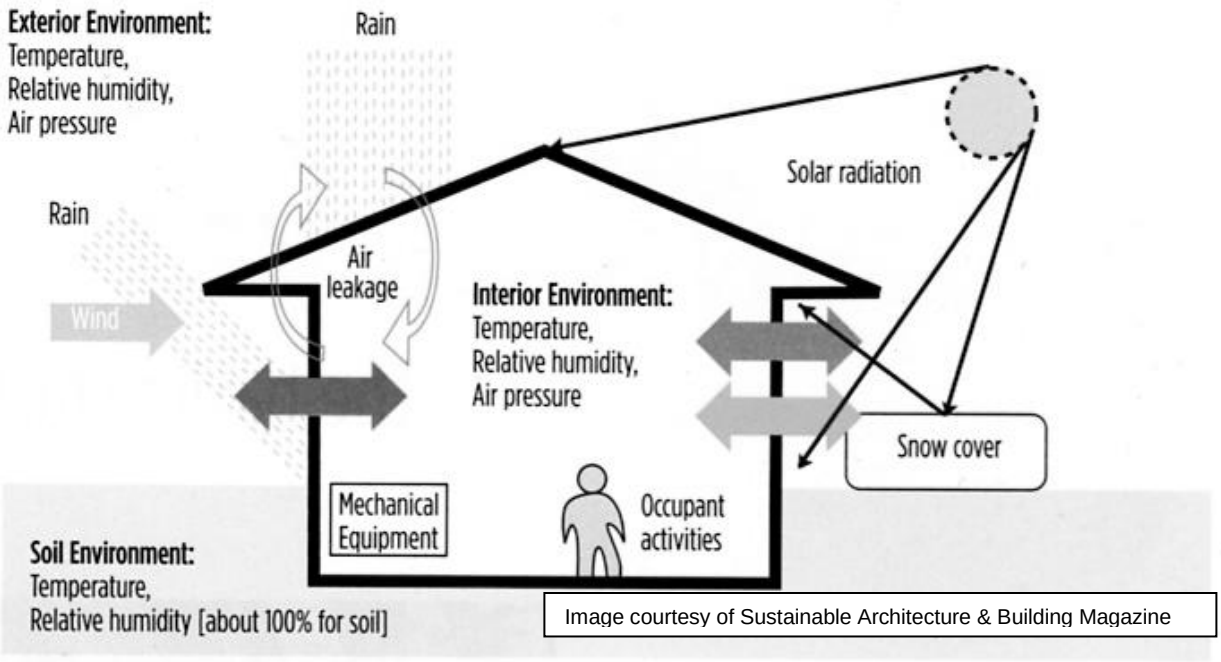

Figure 2 **Environmental loads of building envelope**

Load: Vapour pressure difference Load: Air pressure difference Load: Temperature difference

Building Science has arisen as a direct result of building failures over the past 60 plus years. These building failures have been the result of our attempts to create comfortable, energy efficient homes using light frame construction without proper understanding of the science of buildings, with respect to air and moisture movement. It is a developing science and many products have come on the market to help light frame construction perform better including, synthetic sheeting products such as house wraps, air barriers, reflective barriers. The opportunity for Building Biologists is to take the science of buildings and apply it to a better idea, buildings that are more dynamic, responsive, and forgiving to the elements, the healthy, natural building.