Indoor Environmental Quality & Health **Factsheets**

Building Biology Institute
The science of healthy buildings

“Nature is not a place to visit. It is home.”

—Gary Snyder

CONTENTS

Acoustic Protection

Building Biology Institute Archive

Associated Online Course
In Development

In Development The acoustic properties of a built environment can render the environment pleasant and peaceful, or disruptive and aggravating. Porous finishes tend to absorb sound, whereas smooth shiny surfaces tend to reflect sound, thereby causing noise interference. The exact level at which a person is disturbed by noise is subjective, and thus varies from individual to individual. IBE cites several adverse effects to noise exposure including: loss of concentration; increase of blood pressure; release of stress hormones; contraction of blood vessels (stenosis); decreased digestion due to negative impact on peristalsis; and ulcers.

Varnish that seals all surface pores creates a very smooth surface. As a result, the sound absorption capacity of this surface will be very low. Since sound waves are easily reflected, noise levels will be higher. This is to be avoided in indoor environments, especially those with large surface areas. Mass wall materials on the interior of a home not only contribute to a more even climate, but when used in the proper locations, they can also block airborne noise transference between rooms. Adding mass or insulation between floors can also help to prevent airborne transfer of noise between stories.

Acoustic isolation is required to prevent vibrational transfer of noise. Staggering studs helps avoid this problem, so there is no sound bridge in a wall or floor.

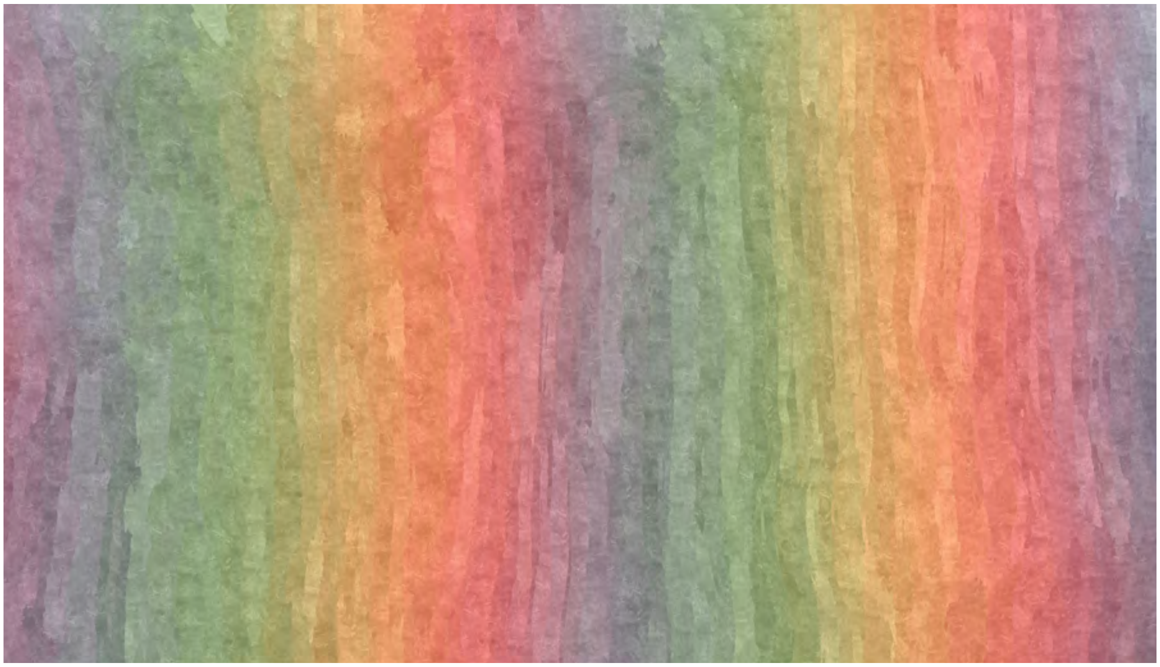
Outdoor-Indoor Transmission Class is a standard that is used to rate the transmission of outdoor sound into indoor spaces. It is more heavily weighted to the lower frequencies of air, rail and road traffic. Some municipalities in the U.S. have established day-night noise level standards in decibels which building envelopes must withstand. Window and door openings are structural weak points with respect to sound transmission from air and ground traffic. Several things can be done to lessen this sound transmission, such as careful detailing and good insulation around the window framing and increasing the layers and quality of the glass.

From a Building Biology perspective, a window's main purpose is to open and let in fresh air. Making the windows more sound-proof, in conjunction with mechanical air filtration/ventilation, can improve living conditions in homes where street noise exists at unacceptable levels. Homes can be designed with quiet central courtyards and intentionally planned with quiet rooms, such as bedrooms facing the courtyards and with ample operable windows. The building itself can act as a sound buffer for the quiet interior courtyard. Utility rooms and more active rooms (such as kitchens) can be placed on the traffic side of the building, with minimal glazing. However, these measures do not replace good municipal planning, which includes separation of major thoroughfares from dwellings and employing planted, bermed green zones between the two.

Insulation will noticeably reduce airborne noise and improve the Sound Transmission Class (STC) rating of exterior walls. Staggered or double stud walls achieve higher ratings than single stud walls. Metal stud walls perform better than wood stud walls, although they are not desirable according to Building Biology principles. Putting surfacing board on resilient channel can improve the STC rating of an assembly, as can adding additional layers of drywall. Solid masonry walls that are thicker than 6 inches will also achieve acceptable STC levels. From a building biology standpoint, these are a very viable solutions, since the walls will also add thermal mass for climate control.

In North America, acoustic tiles are commonly used for commercial buildings and schools, and are sometimes used in residential construction. They are designed to reduce noise and hide services (i.e. wiring, duct work) above the ceiling in dropped ceiling designs. Cellulose fibers with a facing of Kraft paper are the most common material used for ceiling tiles. Gypsum is also sometimes used, but this material introduces the same health issues as drywall (or sheet rock). Associated health problems with gypsum are mostly related to the dust, mainly affect the installation worker, as the small fibers splinter off at the edge of each panel. However, this problem can be aggravated as the dust from the "industrial gypsum" may contain a substantial amount of toxic pollutants (i.e. heavy metals). Additionally, a large variety of petrochemicals may have been captured in the industrial cleaning process. It is also possible that "industrial gypsum" is radioactive. Further, the mining of gypsum has a negative environmental impact, and disposing large amounts of toxic industrial gypsum is fraught with challenges.

The Kraft paper used as facing for the tiles is often made from recycled newspaper which could cause a health effect in sensitive people. Many old acoustic tiles contain asbestos, which leads to lung problems from the very fine and shape dust. Builders should take precautions (i.e. use masks), and sensitive individuals must test the entire system (drywall, Kraft paper, joint compound, and wall cover) to ensure it does not cause health problems.



Color for Health

Building Biology Institute Archive

Associated Online Course
In Development

Life is associated with light. Every single living cell, even in darkness, receives and transmits rays of color. The human body, mind and emotions are also highly responsive to color. The human eye has the capacity to distinguish over one million colors. Our well- being can be positively or negatively affected by a wide range of environmental stimuli, such as weather conditions (air temperature, pressure, humidity and air electricity), sound levels, chemicals and more. Humans are particularly affected by cosmic and terrestrial background radiation, and that includes electromagnetic vibrations of color.

Colors are to our emotional life, as spices are to food.

The colors of nature have a very positive impact on the human mind, especially yellow as its energy is most dominant in the visible spectrum of daylight. The human eye is most sensitive to blue, red, and green. The effect of a color is determined by many different aspects, including the hue, saturation, surface texture and quality of a color, as well as the quality of the light (i.e. natural daylight or artificial lighting). Complementary colors, for example, are opposite from each other on the color wheel, and stimulate opposite effects in humans. However, it is important to consider that the experience of color is subjective, depending on one's age, gender, and ethnic background, as well as one's individual color associations.

Warming colors (hues of yellow, orange or red) tend to be exciting. Cooling colors (hues of green, blue and violet) tend to be calming. According to studies by the British psychologist Hans Jurgen Eysenck, adults in the Western world exhibit color preferences in the following order:

1. Blue
2. Red
3. Green
4. Purple
5. Yellow
6. Orange

As we grow older, our relationship with colors tend to change. Dr. Heinrich Frieling, a German color psychologist, called the ubiquitous black blackboard "a poison for a child's mind." The founder of anthroposophy, Rudolf Steiner, developed color schemes for rooms in elementary (or primary) schools as follows:

grade 1: pink/red
grade 2: pink/orange
grade 3: orange/red
grades 4 and 5: pale orange
grade 6: orange/yellow
grade 7: yellow/green grade 8: pale green

The eye is naturally the most prominent gateway of photoreception in humans. But humans also retrieve color information through the skin. A wide range of photoactive molecules are found in almost any tissue, capable of acting as photoreceptors. The absorption of light energy depends on the color's wavelength. Due to their relatively long wavelengths, the warming colors of red, orange and yellow, as well as infrared, are able to penetrate into deeper layers of tissue. Since the cooling colors of green, blue and violet (including UV radiation) have a shorter wavelength, they are absorbed at the skin's surface. The physiological effects of colors are based on the mixture of frequencies, the amount of radiant energy carried by photons of a particular color, and their conversion into heat and/or chemicals, as well as electrical energy.

Though colors in our immediate environment (home, work place, school, clothes) are mediated across other sensory organs, they have similar effects on our well-being. Thus, the temperature perception of a room painted green-blue is usually experienced as 3-degrees cooler than a room tinted orange.

We make countless color choices every day, often unconsciously and automatic. The National Cancer Institute and the Center for Disease Control and Prevention advise everyone to "Sample the Spectrum" of fruits and vegetables for maximum health. It is a scientific fact that the plant pigments that color our food naturally possess powerful antioxidant and anticancer properties. The intensity of a given color guides us to the highest nutrient density.

Community Planning

Paula Baker-Laporte, FAIA, BBEC, BBNC

Associated Online Course

IBE 223.3, IBE 223.4, IBE 223.5, IBE 223.6

Principles 2–4 of the Building Biology Principles concern Community Planning:

2. Place dwellings so occupants are undisturbed by sources of man-made air, soil, water, noise and electro-pollution.
3. Place dwellings in well-planned communities that provide ample access to fresh air, sunshine and nature.
4. Plan homes and developments considering the needs of community, families and individuals of all ages.

These 3 principles although very general must be considered in conjunction with all of the other Building Biology principles of health and ecology that are applied to individual dwellings, including issues of energy efficiency, electromagnetic radiation safety, design for climate and the broadest implications of social well-being and ecology. How do we reconcile human health and ecological living in our cities today with the challenges of air, land and water pollution, the automobile, social problems, and zoning restrictions? In Building Biology, we use nature as the gold standard. By this we mean that we try to emulate the conditions that exist in nature to enhance life. In nature the key to success is symbiosis whereby complex systems operate optimally together in a mutually beneficial relationship.

How do we define and create "well-planned" communities?

How can we meet the needs of community, families and individuals of all ages? These are the questions we will explore throughout the Community Planning set of 4 mini courses. Following is a synopsis of the courses.

Cities in Crisis

"Cities in Crisis" is the first of the Building Biology on-line mini-courses about community planning. In it we examine the beginnings of human settlement in Europe, the growth of the city and the planning theories that shaped the built world up until the time of Bau-Biologie's formation in Germany in the 1960's.

For thousands of years humans settled in community within the natural world and the practice of geomancy shaped human settlement. As the complexity of cities grew various theories emerged regarding the ideal size, shape, and arrangement of cities. From the early city-states to suburbs and modern mega cities, community planning theories have been explored in attempt to solve the problems unique to each era of history. With the Industrial revolution a rapid and unprecedented migrations to the city brought with it massive problems of sanitation, overcrowding, urban poverty and crime. Two theories of how to solve the ills of our cities emerged in the early 20th century and were the backbone of planning decisions at the time of Building Biology's formation. Both, as they came to be realized through early 20th century planning initiatives, had major negative impacts on the health of our cities.

Decentralization, sought to solve the over population and rising crime rates within the congested cities by enticing the population out of the city into planned communities. The Garden City Movement championed by Ebenezer Howard resulted many desirable "new town" developments throughout North America and Europe but the credo of fresh air and a patch of grass for everyone also resulted in massive suburban sprawl and along with it sterile, automobile-dependent suburbs that robbed once vital city centers of their tax basis replacing their former vibrancy with urban blight.

Centralization sought to solve over population and ground congestion by stacking the population into high rise towers leaving the ground as a park-like landscape with mass underground transit joining the network of work and living towers. Championed by Le Corbusier and the Radiant City Movement, the resultant popularity of slum clearance projects lead to the bulldozing of valuable urban fabric and replacement with ill-conceived, crime-ridden high rise public housing projects that remain a scourge of so many cities today.

Jane Jacobs, in her poignant critique of both schools, summarizes the state of community planning in the early 1960's: "In its relatively easy public reception Le Corbusier's Radiant City depended upon the Garden City. The Garden city planners and their ever increasing following among housing reformers, students and architects were indefatigably popularizing the idea of the super block, the project neighborhood, the unchangeable plan, and grass, grass, grass: What is more they were successfully establishing such attributes as the hallmarks of humane, socially responsible, functional, high-minded planning."

Building Biology Roadmap for Sustainable Cities

The Building Biology Principles for healthy community planning were born in the light of the failure of the current planning ethos to create vital cities that served the health and well-being of their citizenry. In the second mini-course we examine the Post WWII city planning that preceded the Building Biology movement and was at the root of the health crisis that birthed it.

At the time of the original building biology writings in the 1970's city planning theory had resulted in a new sort of ailment. The worst slums of the industrial revolution (at least in Western Europe and North America) had been successfully sanitized through slum clearing, and the implementation of draconian zoning laws. But the post war cities now suffered from a new form of ailment characterized by sterility and alienation. Zoning laws and city plans based on the automobile created great separations between work, schools, shopping and homes. Dominated by the implementation of unproven and simplistic theories of urban renewal that were widely adopted, the very fabric that makes a great city great was completely ignored. Decades later these experiments were unanimously declared to be failures.

The Building Biology recommendations for city planning can be summed up in a single sentence: Through appropriate urban planning, transform cities from soulless landscapes and restore them in to life-sustaining and life-affirming centers of human and environmental sustainability.

There are six main areas that Building Biology addresses and underlying all is the holistic approach to human health and planetary ecology from the scale of individual homes as well as to the communities that surrounds them.

1. Create comprehensive, place-specific urban design guidelines- The key phrase here is "place-specific". Cities, because they are the creation of mankind, originate in and are intrinsically connected to the nature of the place in which they are located. This is the foundation of what makes a City a unique and special place. Building Biology calls for an honoring of the place and the past as we move forward.
2. Reinstate and reinforce the vitality of public space: By the 1970's, much of the vitality of urban centers had been drained as people and the tax base they contributed fled from unlivable cities to the suburbs. It is common to find, in ailing cities, a central business district, devoid of night activity in a landscape filled with lifeless institutional buildings, expressions of financial might rather than human scale with streets too dangerous to be in after hours.
3. Green the city by inviting nature back in: Humans have an elemental connection with nature and feel a sense of well-being when surrounded by plant life.
4. Reduce the negative impacts of vehicular traffic: Vehicular-centric city design has resulted in loss of human scale, visual blight, noise, air and ground pollution, isolation of the young, the old and the poor who do not have access to personal transportation and dependency of fossil fuels. The traffic-dominated street does not work well as a place of communication and interaction.

5. Manage rainwater ecologically, as a natural system: Water usage in the United States and Canada is staggering as compared to other parts of the world. According to the EPA, the average family of four can use 400 gallons of water (1,514 liters) every day, and, on average, approximately 70 percent of that water is used indoors.
6. Integrate renewable energy and energy reduction into city planning: Strategies for reducing the energy requirements and dependence on technologies for individual buildings are discussed in depth in the IBE 215 seminar and manual. Planning for the wise use of natural and renewable resources on a community-wide level will have the greatest impact.

The Building Biology criteria for community planning, although formulated decades ago, are even more relevant today as our cities continue to grow in number, density and size and an increasing number of their inhabitants face the problems of unhealthy and stressful living conditions.

Current Movements in City Planning: Building Biology Ideals in Current Practice

By the 1980's a new movement in urban design was brewing in reaction to urban deterioration and suburban sprawl. This movement looked to draw people back into the center of the city and reduce the dependency on automobiles and fossil fuels. At the same time, it was trying to re-introduce a sense of community into urban neighborhoods. These exciting developments are the topic of the 3rd Community Planning mini-course

City planning movements including New Urbanism, Cohousing, the Transition Movement, the Pocket Neighborhood, and Eco-hood all reflect aspects of the Building Biology vision for a better built world. While each presents a unique perspective on the revitalization of our urban neighborhoods, similarities include creating diverse, self-sufficient neighborhoods which support a variety of activities, transportation modes, and inspire community participation.

Whereas the Garden City and Radiant city movements upon which early North American planning initiatives were based, the examples shown in this course are North American and reflect inspiring solutions that are uniquely applicable to our urban fabric

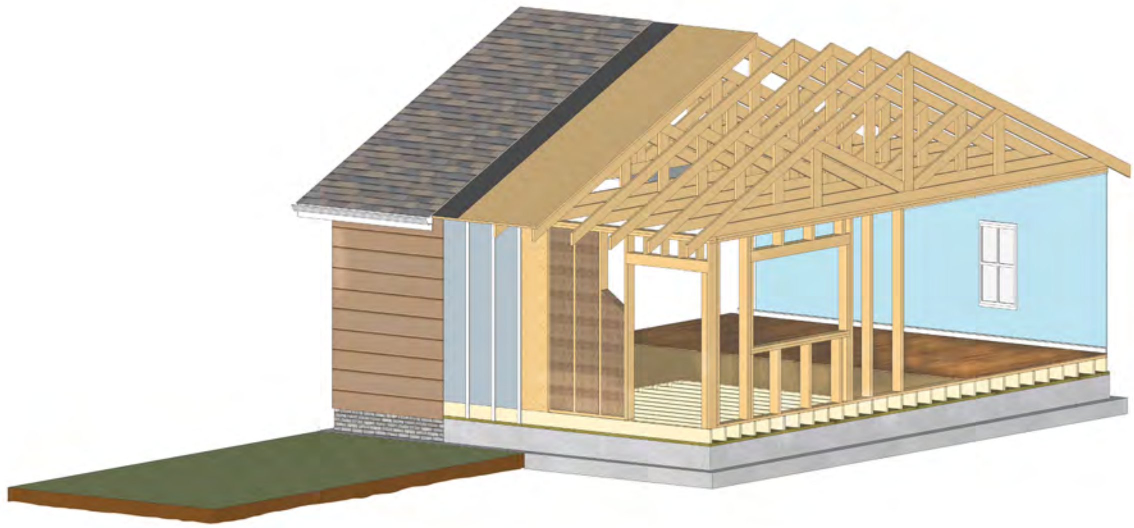
Each solution provides ample access to fresh air, sunshine and nature, by virtue of the implementation of good planning principles. Each also integrates well within the existing urban fabric. Although none to-date specifically addresses the larger Building Biology concerns of healthy natural building materials and freedom from electro-magnetic pollution, they do represent inspiring models where these aspects could be easily adopted by a forward-thinking developer or collective of residents with a holistic Building Biology mindset.

Exemplary Case Studies

The 4th on-line Community Planning course illustrates built case studies that realize Building Biology criteria for healthier cities. Some of the guidelines that are photographically documented include capturing the essence of character that is unique to a city, and creating vital public spaces. Other examples focus on environmental conditions, such as greening urban areas, managing traffic with a balance of mixed uses, managing rainwater ecologically, and integrating renewable energy and energy reduction into communities.

We conclude with the "Peace Treaty" of Friedensreich Hundertwasser. Hunertwasser was the Austrian Architect/artist whose views of mankind, nature and the city reflects the Building Biology philosophy. He was much admired by the original founders of Building Biology. His treaty is between man and nature. It holds the solution for the creation of thriving cities of the future.

1. We must learn the language of nature, in order to come to an understanding with her.
2. We must give territories back to nature that we have wrongly taken and ruined.
3. Tolerance for spontaneous vegetation must be developed.
4. The creation of mankind and the creation of nature will be reunited. The splitting of these creations has catastrophic results for nature and for mankind.
5. Life must be in harmony with the laws of nature.
6. We are only guests of nature and must act appropriately. Mankind is the most its ecological place, so that the Earth can regenerate herself.
7. Human society must again be one without waste—other than that which is generated by the natural cycles of life. In doing this, one respects the cycle of life and allows the reincarnation of life to occur.



Conventional Construction and Health

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Associated Online Course

IBE 223.3

Our homes protect us from outside elements, but there are also indoor elements that can negatively impact our health. They will vary with the age of the home, as different construction techniques over the years created unique air quality concerns unique to that time. By understanding the various construction details over the last 100+ years, homeowners and tenants can make better choices to ensure great air quality within their living spaces.

100+ year old homes typically have air leakage in the wood frame construction of the building, which can bring in dust and particulate, especially through the hollow walls. Their basements often leak water from the ground due to lime mortar. Air sealing the building's frame walls, and managing moisture in the basement are key for this age of building.

Homes in the 20s-30s have insulation in them, but still poor air leakage. Their basements are better, but can still pose problems. These can often be excellent smaller homes with solid building materials.

Homes built after World War 2 were built quickly to accommodate all the returning soldiers. They had more manufactured materials than before the war. They often have cold exterior corners, which are lacking insulation, as a design detail. These are difficult to repair without gaining access to the outside of the house. Knowing the weak points, you can prevent the condensation and mould from developing by keeping corners open.

The 1960s and 1970s saw the use of manufactured materials take a dramatic hold in construction, and added to that was the increased use of chemicals in the building process. These have off-gassed by this point in time, and can be more airtight than pre-war homes. Moisture in the basement, as all other decades can still be an issue, especially if the home has never had the foundation dug out since new.

The 1980s and 1990s saw larger homes, built in the age of "flipping" and "house as an investment, not a home" mentality. These larger spaces did not always mean better quality, and with the more complicated designs came more potential for mould due to leaks and failures. Homes became more airtight in later years, an improvement in comfort and air quality, but with more chemicals added to finishes, cabinets, and floorings, these chemicals stayed longer in homes. Most will have off-gassed, but sensitive people may still have issues.

21st Century homes have more air sealing, more complex chemicals used in construction and lack of ventilation. These homes can still be off-gassing, and if there are water leaks, they are less durable due to the manufactured wood materials used, instead of solid wood.

All homes of all ages have the potential to be healthy. By understanding the construction, and the areas of concerns, you can create your own healthy house.

Designing a Kitchen for Wellness

Charlie Rain Almoney, BBNC

Associated Online Course

[IBE 223.7]

Kitchens are an integral part of every home. Ultimately, kitchens are where we nourish ourselves, feed our families and host guests. However, kitchen design and its effect on human health and wellbeing is often overlooked. Promoting and supporting healthy kitchen environments requires a detailed and comprehensive understanding of Building Biology principles.

As Building Biologists, we are trained and committed to the investigation and analysis of healthy building practices using core principles and techniques rooted in nature. We understand that there is a direct correlation between biological compatibility and ecological balance; the products that support and sustain human health will ultimately sustain the planet. With nature as the Gold Standard, Building Biologists seek to enhance health by creating homes that emulate conditions found within nature; those that support human biology. This design perspective positively impacts not only the quality and longevity of the entire home but also the quality of life for its inhabitants.

In this course, Kitchens Designed for Wellness Part 1, Building Biology principles connecting health with ecology are applied to kitchen design and specifications. Studies indicate that our built environments play a significant role in occupant health. The most reliable approach to avoiding harm, is to avoid potential hazards. Eliminating exposure to toxic substances and making more informed choices about product replacements is a large part of the solution. Healthy kitchen design takes many aspects into consideration and celebrates human interaction with the built environment by promoting health and wellbeing.

Kitchens Designed for Wellness Part 1 will explore the key features in finish, fixture and appliance selection. The five qualitative elements that dramatically impact human biology are air, water, light, acoustics and electro-biology. Students will learn how occupant exposure to hazardous kitchen conditions affects human biology and, more importantly, how to minimize unnecessary risks. This course will explore alternatives and offer insight into design, product selection and building procedures that improve human health.

Recommendations and criteria are provided for evaluating safer kitchen cabinets, countertops, floors, wall finishes and interior paints. Students will learn how to evaluate air, water and light quality and identify unnecessary exposure to electromagnetic radiation as well as noise pollution. Also provided are biological considerations for appliance selection; including electric, gas and induction ranges, microwaves, refrigerators, freezers, dishwashers and sinks.

Kitchens Designed for Wellness Part 2; Living in the Healthy Kitchen (available Fall 2020) offers students the opportunity to learn more about nontoxic product selection and lifestyle choices. This course will explore the dangers of toxins found in cookware, dishes, food storage and mini appliances. It will devote attention to toxins in cleaning products and provide recipes for how to make your own healthier alternatives. This 2-part kitchen series, taken together, invites a holistic evaluation of many common kitchen products and practices we generally regard as "safe". The class will explore how we, unknowingly, contribute to poor health outcomes for our families and our clients. Students will also learn effective strategies for optimizing any wellness kitchen with easy to integrate routines, including a "roadmap" for how to manage kitchen maintenance and inspections. Both courses are written for individuals within the building and design trades as well as homeowners.

Flow-through Walls & Moisture Control

Building Biology Institute Archive

Associated Online Course

In Development

Health and ecological criteria are the most important considerations in a Building Biology evaluation of a home, school, or office. Most natural options for building materials are more expensive than their industrial counterparts (with the exception of non-commercial products such as sawdust). But the cost of insulating a home is a small drop in the bucket compared to the comprehensive cost of building a home.

Natural insulation materials made from wood byproducts and agricultural fiber are abundant, and can be easily treated by natural and non-toxic methods for fire-resistance, mold and vermin. In North America, a small selection of natural fiber insulation products are commercially available at this time. Internationally, some countries have developed a larger array of insulation products from natural fibers like wool and hemp. Hopefully, it will only be a matter of time before these materials are distributed and manufactured in the United States. These natural options are low in embodied energy, non-toxic, and suitable in a "flow-through" building envelope system.

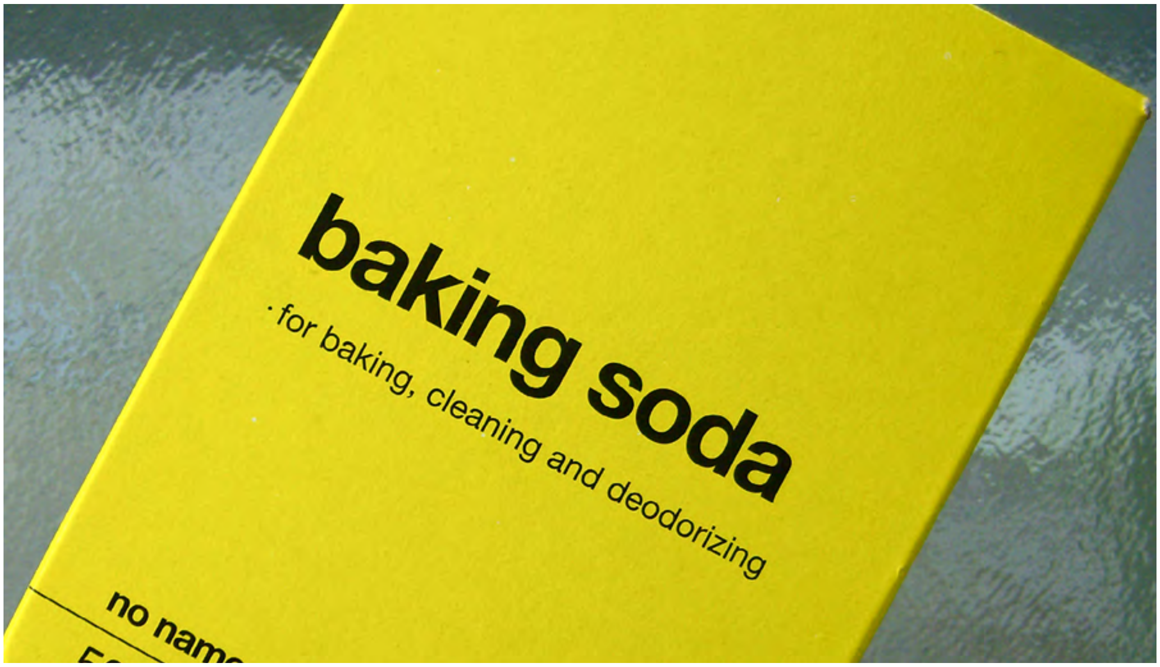
Building Biology strongly suggests using alternative natural materials, such as earth and straw, as an option for building a healthy home. Historically, these derived methods of construction differ from the standard cavity wall construction techniques, in that manufactured vapor and air barriers are not installed to retard the flow of air and vapor through the walls. Instead vapor and air are allowed to naturally flow through the massive walls. Because temperature change in the flow-through process occurs very slowly, and because dried mud has the ability to absorb and desorb large amounts of moisture without deteriorating, accumulation from condensation is insignificant. When a home is properly constructed using these mass wall techniques, the resulting environment will be comfortable for occupants, with a high degree of temperature and humidity stability. Furthermore, because the solid walls themselves provide insulation, and can be finished with a covering of plaster or furred-out wood applied directly, this eliminates the need for synthetic exterior sheathing, batt insulation, gypsum board, joint fillers, and paint. This also removes and reduces many sources of volatile organic compound (VOC) contamination in the home.

Historically, the building envelope (walls, floors, and roofs) of dwellings were made of materials harvested from nature (i.e. stone, wood, agricultural fiber and clay). These materials were vapor permeable or with diffusible membranes. In Building Biology, a building envelope that allows for the unobstructed flow of vapor molecules is known as the breathable wall. Other more appropriate terms for this type of building envelope are: vapor diffusible wall, vapor permeable wall, or flow-through wall system.

It is only relatively recently that buildings have incorporated layers of impermeable plastics into the building envelope. Modern conventional home construction most often consists of spaced 2x6 wood stud construction, with fiberglass batt insulation in- between. When water vapor is allowed to flow through this type of wall, it reaches its dew point. Liquid water within the envelope soon causes harm to the building envelope. Moist fiberglass batts lose most of their ability to insulate, and the constant exposure to water causes the wood and the wallboard to mold and rot.

For this reason, a number of strategies are now employed in conventional construction to prevent water vapor from entering the building envelope. These strategies include: putting a vapor retarder on the warm side of the building envelope; using paints and building envelope coverings with low perm ratings to prevent moisture-laden warm air from entering the wall; and cooling and then condensing within the wall cavity.

Formerly, these barriers were all called vapor barriers, but because they were not vapor impermeable (usually due to assembly errors or breaks in envelope integrity), they have been renamed "vapor retarders" for applications above grade since 1980. Quite often, over time, these barriers do not work as expected. In much of the country, the warm, moist side of the building envelope is on the outside during the summer and on the inside during the winter. Once water finds its way into the building envelope, it is unable to escape because of the barriers that are in place.



Healthy Cleaning Products

Larry Gust, EE, BBEC, EMRS

Associated Online Course
In Development

There are three words that should always come to your mind when evaluating whether to introduce any modern cleaning product into the home: Volatile Organic Compounds (VOCs). VOCs are carbon and hydrogen bonded compounds that can easily evaporate at room temperature and enter the home's indoor atmosphere as a gas. There is no common chemical structure among VOCs. They can range from short carbon chains to more complex aromatic rings. Prime examples are solvents and chemicals commonly found in contemporary house cleaning products.

Of secondary but no less important concern are SVOCs (Semi-Volatile Organic Compounds), which require temperatures higher than room temperature in order to self-convert to a gas. As with VOCs, when SVOCs exist in product containers that have been opened, breaking their tamper-proof seals, those containers will not fully reseal and will leak VOC and/or SVOC vapors.

Commonly used household products that contain potentially carcinogenic VOCs and/or SVOCs include, but are not limited to: dryer sheets, fabric softener, laundry detergent, carpet cleaners, liquid spray air fresheners, plug-in air fresheners, and solid disc deodorizers (such as those used in commercial airplane toilets).

In a scientific study, these six products collectively gave off nearly 100 VOCs, including three chemicals that the Environmental Protection Agency (EPA) considers "hazardous air contaminants and pollutants" with no safe exposure levels. This list includes the likely human carcinogens acetaldehyde and 1.4-dioxane, as well as methyl chloride, which has been linked to liver, kidney and nervous-system damage in animals. Studies have also found evidence that other chemicals, such as Bisphenol A (BPA), associated with both diabetes and obesity, are still widely produced and found at detectable levels in the environment. BPA in particular has been the focus of many campaigns calling for it to be banned, although it continues to be used to line plastic bottles and food containers.

Exposure to chemicals through everyday household products was evaluated in a study where homes and urine samples were tested for 89 environmental contaminants, including pesticides and chemicals found in plastics, cleaning products and cosmetics. On average, twenty (20) chemicals were detected in each participant. Furthermore, researchers have found that cleaning products and air fresheners can produce formaldehyde (i.e. the chemicals in pine oils and citrus oils react with ozone in the air, producing airborne formaldehyde).

An easy way to prevent exposure to indoor toxins is to avoid using all fragranced products.

Healthy Radiant Heating

Building Biology Institute Archive

Associated Online Course

In Development

Radiant heat warms the building, materials, and contents. It does not warm the air itself. Radiant heat is the more biologically preferable and energy efficient methodology for heating an indoor space. There is a reason that we enjoy standing in front of a sunny window in winter, and feeling the warmth of radiant energy from the sun. Radiant heating sources within a house provide a similar comfort, in that they directly heat the body, rather than the air around the body.

Radiators: Historically, radiators are the most common form of radiant heat, but they can be costly to install and repair due to lack of knowledge by modern forced air furnace technicians. Newer European designs (i.e. radiant towel racks) are more efficient and have smaller clearance. When properly installed, they should last for decades. The primary downside to radiators is they take up floor space, typically underneath windows. Decorative covers do exist, if so desired, to conceal the radiators, or to make a flat usable surface on top. The covers, however, should allow proper ventilation for the radiator out the top. Radiators are placed in front of windows to create a curtain of heat that protects the comfort of those inside the room, and to reduce the cooling effect that the glazing has upon the space.

Radiant heat is biologically preferred for humans. For most of history, we have gained our thermal comfort from our favorite radiator – the sun. Within a house, radiant heat is far more efficient than forced air systems, which primarily heat the air itself, not the objects and surfaces inside. Our bodies function and respond better to an increase in surface temperature versus an increase in air temperature. Imagine sitting outside on a warm rock on a cool day. We experience more comfort in warmer materials and cooler air. When we try to heat the air and not the contents, it is far more difficult to reach an ideal temperature. With radiant heat, our thermal comfort range is increased, and therefore our well-being is improved. Studies have also shown that we can in fact lower the overall temperature of the space with respect to air temperature when the surfaces are warm. This in turn improves the energy efficiency of the space, as the thermostat can be set at a lower point than if using a forced air system, ultimately maintaining optimal comfort while saving money and the environment.

Although not as efficient as larger radiators, baseboard radiant hot water heating can be used successfully in residential applications. Radiant wall heating, although not common in North America, is a dynamic heating strategy and is the best solution for reducing air stratification. Loops of water are installed directly into the wall system and then plastered over. Some locations even have ceiling loops, but this would only be required in a situation with multiple source radiant heat, such as in a spa room.

Radiant Floor: Radiant floor heating is becoming more common in North America. Loop distance (or the spacing between rows of tubing) is determined by heat loss calculations, in order to create even heating. Heat loss is calculated based on construction details, such as insulation, window sizes, amount as a percentage of wall area, and locations. This accurate energy representation can be modeled to determine the best layout. Typically, the spacing between rows of tubing is approximately 6-8 inches apart.

IAQ for You

Healthy Radiant Heating

Associated Online Course

IBE 222.2

Biological

All creatures need food and water. Manage pests of any size—from large (rodents) to small (bugs) to very small (mould) by keeping your building dry and clean. Manage moisture entry points in the building's envelope to prevent water from getting into your walls and roof. Be sure to monitor plumbing for leaks and control spills in the home. By keeping building materials dry, you can curb the ability of tiny pests like mould to take hold. That is because they prefer damp building materials to eat. For pests that eat the same foods as we do, maintain a clean home through regular maintenance and putting garbage in sealed waste bins to help prevent them from moving into your space. These same efforts at keeping your building dry and in good shape will lower the potential for mould to take hold. as After all, it requires the same conditions as larger pests. Without damp cellulose materials, mould cannot thrive. Maintaining a clean, dry space will resolve most biological concerns in a home without the need for chemicals to remove pests. After all, you don't have to kill or drive out a pest that never enters your home.

Particulate

Particulate presents a concern in the form of very small airborne materials we may breathe into our lungs. If it is tiny enough, ultra-fine particulate can directly enter our bloodstream. A myriad of materials and elements can make up particulate. Children are more vulnerable to dust, and more likely to be exposed to it on floor surfaces where they play. The simplest way to deal with particulate is to clean more often. Effective methods include wet wiping and vacuuming using a vacuum with a HEPA filter, which captures the smallest particles possible. If you do not have a HEPA vacuum, open the windows while vacuuming to release stirred-up particulate. Remove soft surface flooring and replace it with solid surface to reduce ultra-fine particulate. Homeowners should clean the building's ductwork, add a better air filter to the furnace, and air seal the home. Taking these steps will cut down on particulate entering the home and circulating throughout.

Chemicals

Cleaning products are the main source of chemical exposure in most homes. Dispose of your chemical cleaners at a hazardous waste depot and switch to natural-based cleaning products. Volatile organic compounds (VOCs) have an odour at room temperature and can harm our health. Do not buy any personal care product, cleaning product, or building material that has VOCs if at all possible. If you are unable to replace or remove the source of chemical exposure, your next best options are to ventilate and/or encapsulate. Do not use pesticides; they will affect human health as well as the pest's. Learn to create inhospitable climates for pests before they invade so that pesticides are not required. Choose building materials with low formaldehyde that are more natural-based to reduce the chemicals present.

Indoor Climate

Building Biology Archive

Associated Course

IBE 222.7

“Living Climate” refers to the atmosphere of a living space. It captures and displays the essence of a home, fills the outer form with life, and creates either harmony or disharmony. Living climate is not to be confused with “Climate,” which encompasses the range of weather conditions that occur over long periods of time on a global scale.

The selection of building materials, the type of construction and the type of heating system determines the quality of the living climate in a given home. The tangible and intangible aspects of a dwelling affect the mind, body and soul in a myriad of ways.

The way we build our homes and the type of building materials we use have a profound impact on our quality of life. There is a clear and fundamental connection between our health and the built living spaces and workplaces we occupy. Those who make building decisions have the unique opportunity to create better places (or worse ones). In this course module, the discussion on indoor climate is not limited to indoor air quality (IAQ), but includes many additional aspects that can be applied to residential homes as well as schools, hospitals, institutions, office workplaces and workshops.

Modern housing can and does make people sick. The list of potential indoor pollutants and the effects of low-level electromagnetic fields is growing longer each year. The symptoms caused by sick homes can be classified as: Sick Building Syndrome (SBS); Building Related Illness (BRI); and Environmental Illness (EI).

Bioclimatology is a branch of science concerned with the interaction between climatic factors and living organisms. The four major spheres of influence that affect indoor climates are: air, temperature, humidity and electro-climate.

The sheer amount of individual climate factors is enormous. Adding to the complexity, the possibilities for interactions and synergistic effects are nearly limitless. From the perspective of bioclimatology, it is dangerous to reduce indoor climate solely to the temperature and humidity of the air. Modern homes tend to harbor many toxic chemicals, trap enormous amounts of dust in the carpeting, foster rampant mold in the walls and house electric wiring everywhere.

Additionally, the climate within our own homes is substantially influenced by distant places, including the climate of outer space, the earth's atmosphere, urban pollution, air pollution, and climate change. External influences reach us from outside as well as inside the earth's atmosphere.

Each single climate factor seems to be affected by the quality and type of building materials in one way or another, including: air and surface temperatures; horizontal and vertical temperature gradients; air humidity and building moisture; regulation of air humidity; air movement; natural ventilation; electromagnetic qualities of a living space; odor of indoor air; absorption of toxic air pollutants; growth of mold and dust mites; overall atmosphere of an indoor space and its impact on the occupants' well-being.

Moisture damage is the single most critical problem. Different climate regions require different approaches to building. One standard building practice certainly does not fit all situations, especially not minimum requirements. With or without vapor barrier, the complex dynamics of a building envelope always call for a careful design and installation. Inappropriate waterproofing of the foundation and inappropriate installation of vapor barriers not only cause great discomfort to the occupants, but also result in major damage to the building.

In the endeavor to reduce energy consumption, modern houses have become more and more airtight. Without appropriate ventilation strategies, however, indoor air quality problems are inevitable. Not only are dangerously high levels of air pollutants and carbon dioxide reached, but moisture condensation problems become common. The tighter the building envelope, the more likely that a mechanical ventilation system needs to be installed.

Traditional building practices native to a particular climate region and based on building biology principles offer natural ventilation solutions for energy-efficient, healthy homes.

Managing Moisture in the Home

Stephen Collette, BBEC, BBNC, LEED AP, CAHP, BSS

Associated Course

[IBE 222.7](IBE 222.7)

Liquid Water

Bulk or liquid water can cause the most damage to building materials and contents. Managing bulk water entry points through the building envelope, by regular inspection and maintenance of the roof, and penetrations in the wall such as caulking around windows and doors is critical to minimize water intrusion. Cracks in basement walls and grading around the building will impact water migrating into the basement. Water leaks are the internal source of bulk water and all plumbing should be inspected for leaking periodically to ensure faucets are secure, caulking is in good condition around tubs, and toilets are secure to the floor. These strategies will reduce the potential for bulk water to impact the home. Consider how snow may be piled in winter in cold climates, and in hot dry climates, where the heavy short rains may run off as well, when inspecting in different seasons.

Water Vapour

Water vapour can also severely damage a home, typically taking a longer time frame though. Kitchen and bathroom fans should be operational, used, and exhausting to the outside through properly installed hard, insulated, ductwork. Both require regular cleaning for maximum effectiveness. Purchasing the quietest fans possible helps ensure that family members will use them. Hard wiring with a humidistat in the bathroom helps maximize its value and effectiveness.

Managing Moisture

Keeping basements and crawlspaces dry, especially ones with exposed soils help reduce the vapour drive from the soil in to the house. This can be done with concrete, or vapour barrier over the soils and the installation of a sump pit and sump pump to lower the water table to help keep the soils dry. Running a dehumidifier in the basement or crawlspace will reduce the overall dampness typically felt in summer in those spaces. Removing and reducing materials in these spaces that can store moisture like carpets and cardboard boxes reduces the dampness and the potential for mould growth. Raised floors are not recommended as they can hide liquid water under the raised floor causing severe damage.

When adding moisture to a home, such as with a humidifier, point source units are more effective than attaching one to a furnace in winter. Point source humidifiers are typically too much moisture for a single bedroom with the door closed, and could cause moisture damage. Consider putting humidifiers in a hallway with the bedroom doors open to help moisten the air when sleeping.

Water Loss Events

When catastrophic events such as flooding does occur, it is important to act quickly to remove the source of the water, then remove the bulk water present in the home. The next step is to provide dry air with a lot of air movement and to exhaust the wet air at the same time. Where there are areas that are wet and cannot be reached, they need to be opened up at this point, and then remove the materials that cannot effectively be dried or are too damaged. By focusing on these steps, water damage and mould growth can be dramatically minimized.

Nontoxic, Natural Finishes

Building Biology Institute Archive

Associated Course

IBE 222.6

The late Dr. William Rae, Founder and Director of the Environmental Health Center—Dallas, suggests that our bodies are like a rain barrel. Every day, we dump in pollutants from the foods we eat, the water we drink, and the air we breathe. Some of the pollutants are stored in our body's adipose (fat) tissue, some is used for energy, and the rest is expelled. Over time, this total toxic load will eventually "overflow," revealing environmental sensitivities, allergies, autoimmune illness, and chronic disease.

Many commercial paints and finishes contain chemicals that are considered "Hazardous Air Pollutants" according to the Environmental Protection Agency (EPA). In the United States, preliminary clean air regulations were initially adopted in the late 18th century during the Industrial Revolution. The national Air Pollution Control Act was not enacted until 1955. The Clean Air Act, as it has been called since 1963, regulates a wide range of air pollutants that contaminate outdoor and indoor air conditions. Volatile organic compounds (VOCs) contribute greatly to ground-level ozone, which is a major component of smog. Through federal regulatory guidelines, the EPA sets VOC emissions for consumer products, architectural coatings and automobile refinish coatings. VOC content of flat coatings is limited to 250 g/l therein.

The independent, non-profit organization Green Seal (USA) expanded the EPA's VOC emission standards one step further, awarding its seal of approval solely to those interior paints containing less than 50 g VOCs per liter (flat) or 150 g per liter (non-flat). For example, after a fresh paint application, indoor VOC levels can increase up to 1,000 times compared to outdoor levels. The GreenGuard Environmental Institute issues allowable emission levels for VOCs at 0.5 mg/m3. In Canada, the Environmental Choice Program grants certification for paints containing less than 200 g VOCs per liter. In Germany, the Blue Angel program sets similar standards.

Conventional paints contain up to 800g VOCs per liter. In comparison, all certified low- emission paints, especially Zero VOC paints, are better, low- or non-toxic, choices. Nonetheless, it is important to be educated on the specific details of each certification. A product that is labeled "green" does not necessarily mean it is totally harmless. Zero VOC paints, for example, are allowed to contain up to 0.5 g VOCs per liter. And as soon as colorants are added, more VOCs are introduced, although in small amounts. Many latex paints also have biocides added.

IBE's rules of thumb for surface finishes in a home are as follows: paint as little as possible, and where you do paint, use finishes purchased from a natural paint company (which fully declares all ingredients), or mix your own finishes from natural non-toxic products. How to determine if a finishing product is harmful? Request an MSDN safety sheet from 3E Company, or search by product on their website: http://www.msds.com.

Reducing Toxic Combustion Byproducts

Building Biology Institute Archive

Associated Course
In Development

Gas, oil, coal, wood, and other fuels burned indoors consume valuable indoor oxygen, unless air for combustion is supplied from the outdoors. In tight, energy efficient buildings, these fumes can often lead to serious health consequences. Indoor combustion occurs in fireplaces, woodstoves, gas-fired appliances (such as ranges, clothes dryers, and water heaters), furnaces, gas- and kerosene-fired space heaters, and oil and kerosene lamps. The potentially harmful emissions include: nitrogen dioxide, nitrous oxide, sulfur oxides, hydrogen cyanide, carbon monoxide, carbon dioxide, formaldehyde, particulate matter, and hydrocarbons from natural gas fumes such as butane, propane, pentane, methyl pentane, benzene, and xylene. The indoor levels of these pollutants are determined by the amount of fuel burned and the rate of exchange with outdoor air.

Some of the possible sources of combustion by-product gases include: gas stoves, improperly vented hot water heaters, and furnaces. Hazardous fumes can leak at the pipe joints and remain undetected, especially if they occur under flooring. In addition, each pilot light adds fumes, and the burning process itself releases fumes into the air.

Exposure to gas fumes primarily impacts the cardiovascular and nervous systems, but exposure can also affect any organ of the body. Some of the early symptoms from exposure to gas fumes include: depression, fatigue, irritability, and inability to concentrate.

Carbon monoxide is commonly produced during incomplete combustion, particularly from gas-fueled appliances. Carbon monoxide quickly diffuses throughout the entire building (home, school, office, etc.). Chronic exposure can result in multiple chemical sensitivities, because carbon monoxide has the ability to interfere with the detoxification pathways in the liver, allowing the accumulation of toxic substances. Other effects of chronic carbon monoxide exposure include heart arrhythmia, decreased cognitive abilities, confusion, and fatigue.

Carbon dioxide is produced from burning natural gas. Elevated levels result in decreased mental acuity, loss of vigor, and fatigue. Nitrogen oxides are also released from gas appliances. A major source of contamination is the gas stove, particularly older models with pilot lights. These gases are known to impact the nervous and reproductive systems.

Coal, gas, and wood-burning fireplaces that are not equipped with sealed doors emit particulate matter as well as toxic fumes. They also consume indoor oxygen, unless fresh outdoor air is supplied to them. Particles not expelled by blowing or sneezing can find their way into the lungs, where they can remain for years.

It is important to mention that when an automobile is parked, or operated in an attached garage, gas, oil, and other volatile organic compounds diffuse into the structure and will affect the air quality in the home. Garages must therefore be properly isolated from the main structure.

Well-ventilated and well-sealed sources of combustion can be operated with very little degradation of indoor air. However, even sources of minimum exposure must often be removed from the homes of chemically sensitive patients to restore their health.

Ventilation

Building Biology Institute Archives

Associated Course

IBE 222.9

The air we breathe today is often polluted by an extensive range of particulate and gaseous toxins generated by furnaces, power plants, factories, automobiles and myriad other sources. Although the Clean Air Act of 1970 helped reduce air pollution, there are still many “non-attainment” areas where current criteria and standards for air pollutants (i.e. carbon monoxide, sulfur dioxide, nitrogen dioxide, and particulate) are not met.

Particularly in major urban areas, industrial centers and traffic hotspots, “dirty air” is not just a nuisance, but also poses a health risk, including a broad range of respiratory diseases, lowered immune response, higher incidence of infectious diseases, lower life expectancy, and psychological disorders. Furthermore, susceptible individuals may develop symptoms at much lower exposure levels of air pollutants.

The quality of outdoor air has a profound impact on indoor air. Without appropriate controls, indoor air is often far more polluted than outdoor air. Conditions for both outdoor and indoor air must be properly assessed to provide the healthiest ventilation and air-conditioning solutions.

In enclosed spaces, human breathing causes an increase in carbon dioxide levels, and a decrease in oxygen levels. At rest, humans breathe about 500 milliliters (ml) of air per breath. Exhaled air contains about 16% oxygen and 4% carbon dioxide, in contrast to the inhaled air which has 21% oxygen and 0.03% carbon dioxide. Sensitive brain cells are the first to be affected by a lack of oxygen and an excess of carbon dioxide.

A fundamental law in biology says that humans thrive in oxygen-rich environments and perish in carbon dioxide-rich environments.

Other types of air pollutants such as carbon monoxide, sulfur dioxide, nitrogen dioxide, aldehyde, hydro- carbon and dust also cause ill health, intolerable discomfort, as well as a lack of performance. Fossil fuel combustion, polluted outdoor air and smoking are some of the major pollutant sources.

The minimum air exchange rate of a given room should be chosen so that, at the lowest indoor surface temperatures to be expected, the indoor air humidity is also low enough to prevent condensation from occurring on any surface. If the climatic condition does not allow for ventilation to reduce humidity sufficiently, air dehumidification must be used.

In indoor spaces, the number of harmful microorganisms (bacteria, fungi, viruses) increases with the number of occupants, and decreases with the frequency of the air exchange rate. With an appropriate ventilation strategy, sufficient sunlight exposure and the selection of natural anti-microbial building materials and finishes, the indoor germ count can be substantially reduced.

A supply of fresh air should be ensured for the following reasons:

- To provide sufficient oxygen (outdoor air: 21% oxygen)
- To avoid increased levels of carbon dioxide and other air pollutants
- To regulate indoor air humidity (except as noted in a hot, humid climate)
- To avoid odor pollution
- To reduce levels of microorganisms
- To supply negatively charged air ions

Issues to consider with whole-building ventilation that will be dependent on the home construction and climate:

- How much outside air do you need?
- How do you distribute it throughout the house?
- How do you clean it?
- Do you add moisture or subtract moisture?
- Do you add heat or subtract heat?

In the past, natural air infiltration was a major contributing factor to the air exchanges in a house. However, the more tightly modern houses are sealed for energy efficiency, the more a proper ventilation strategy becomes important. The less often windows are opened, and the tighter a house is sealed, the more mechanical ventilation becomes necessary.

In order to minimize the heat loss associated with ventilation, controlled ventilation systems with heat recovery are now promoted and subsidized. However, if they are not properly sized, installed and maintained, they can actually pose a health risk.

We differentiate between the following types of natural ventilation:

- Natural Air Infiltration
- Stack Ventilation
- Manual Window Ventilation
- Automatic Window Ventilation
- Mechanical Ventilation

Air conditioning is a type of controlled ventilation whereby the circulating air is chilled to the dew point to remove humidity from the air. Though not recommended for a Bau-biologist home, most homes today have a mechanical, often forced air, Heating, Ventilation, and Air Conditioning (HVAC) system. Unfortunately, these systems can often be the source, or at least contribute to indoor environmental problems.

Vetting Building Materials

Andrea Allen Sis, M.Arch

Associated Course

[IBE 222.4]

Current Situation

Indoor air quality is one of the top hazards threatening human health. We spend 90% of our lives indoors, whether at home or work. Poor indoor air quality comes from four main categories of hazards: harmful chemicals, mold (and other naturally occurring hazards), byproducts of combustion, and electromagnetic radiation. The first two exposures, chemicals and mold, can be directly caused by the choices we make in construction and maintenance of buildings.

Conventional construction materials commonly contain carcinogens, mutagens, immune sensitizers, and chemicals that are harmful to the human nervous and reproductive systems and the ecosystem so it is vital for architects, builders, and consumers to learn to recognize indoor air hazards and how to avoid them.

There are many names that together describe the range of concerns regarding ill health affects brought on by current building practices, including Sick Building Syndrome, Building Related Illness, Environmental Illness, Multiple Chemical Sensitivity, and Electromagnetic Hypersensitivity.

While the use of toxic chemicals in construction is commonplace today, there are people and organizations working to change this – to raise awareness of the dangers, to find safe alternatives, and to remove toxins from products. Unfortunately, there is not always clear consensus on which chemicals are of concern and in reality, we know very little about the majority of chemicals in use today.

Evaluating Building Materials and Ingredients

As Building Biologists we should also abide by the Hippocratic Oath. "First do no harm." But when it comes to building products, how do we know what is in them and what effect these ingredients will have on humans and the Ecosystem?

There are three main components to vetting a building product or material: determining if the product has already been researched and certified, determining the chemicals or ingredients used to create a material, and if there are any identified or suspected health hazards associated with the ingredients.

There are several organizations that have created certification systems to identify safer materials to use including: Health Product Declaration, Declare, Cradle to Cradle, Building Green, Pharos, GreenScreen, Green Guard, and CARB II Compliant.

If the product has not been certified, there are several different methods to determine the ingredients including Material Safety Data Sheet (MSDS), Safety Data Sheets (SDS), Health Product Declarations (HPD), Declare labels, and contacting the manufacturer or distributor directly. Used together, these sources can be very helpful, but alone, each has limitations. Evaluating Ingredients

When you feel like you have a complete as possible list of ingredients for a product, there are several tools to help you determine the level safety of each chemical, including GreenScreen for Safer Chemicals, the Chemical Hazard Data Commons, Toxnot, PubChem Open Chemistry Database by the US National Library of Medicine and CAS by the American Chemical Society. There are also red lists or precautionary lists that have been published by organizations from architecture firms and green building / product rating system developers to governmental agencies and science/research institutes.

Because each organization or agency has different ways of categorizing chemicals, there are both overlap and discrepancies among the lists.

We can sometimes find out definitively that a product should not be used. We can occasionally find a product that we know to be safe, but the "grey area" is enormous. Because of this, it is essential to prioritize our decision-making process. Because each person/project will have different sets of priorities, it is important to become familiar with evaluating building materials so that you can make the healthiest choices for yourself or your client.

Water Quality Treatment

Paula Baker-Laporte, FAIA, BBEC, BBNC

Associated Course

IBE 222.5

Poor indoor air quality is not the only form of pollution that affects human health. In 2005 the Environmental Working Group (EWG) analyzed more than 22 million tap-water quality tests finding that 260 contaminants were detected in water served to the public.

More than half (141) of these contaminants were unregulated. Not considered in the study were unregulated pharmaceuticals and personal care product chemicals, which were found in the tested water. The good news is that the analysis found over 90 percent compliance with enforceable health standards.

The 1974 Safe Drinking Water Act (SDWA), amended in 1986 and 1996, gives the Environmental Protection Agency authority to set drinking water standards for public water systems with at least 15 service connections or regularly serving at least 25 individuals. There are two categories of EPA drinking water standards: primary and secondary. Primary standards are legally-enforceable standards that apply to public water systems. Secondary standards are non-enforceable guidelines for contaminants that may cause cosmetic effects. The EPA requires public water suppliers to provide a consumer confidence (CCR) report to their customers. To find your CCR by zip code consult the EWG National Tap Water Quality Database at https://www.ewg.org/tapwater/.

Municipally treated water is usually low in biological contaminants because of chlorination, but it is not well-screened for industrial and hazardous waste. The chlorine with which almost all municipal water is treated reacts with naturally occurring organic materials, creating harmful trihalomethanes. This is in addition to the chlorine itself which is a microbial poison.

The only way to assure the quality of what you drink and cook with is by having your own purification system that is carefully and periodically maintained. Typically, purification systems for large municipal water systems can be standard off the shelf systems. Private systems, usually well water, are more difficult because the physical properties of the water may be 'bad' enough to require some form of pre-treatment before purification equipment can be expected to preform reliably for the expected length of time. A credentialed, local water purification individual should be consulted to avoid unnecessary expense due to equipment failure.

The types of equipment available:

- Water Conditioners—used to improve aesthetic qualities. These devices are not purifiers, in the sense of chemical contamination removal. Principle among these are water softeners and iron removal systems used typically on well water.
- Water Purifiers– These remove chemical and biological contaminants.

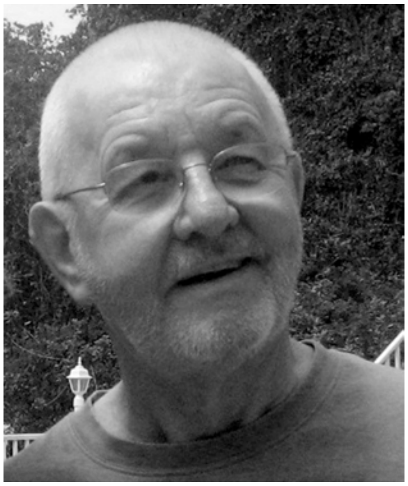
TYPE OF PURIFICATION	FILTRATION ABILITY	CONTAMINANT REMOVED
Steam Distillation	Better than RO	All, depending on design
Reverse Osmosis (RO)	0.001 Millionths of a Meter	Virus, Bacteria, Drugs, Chemicals
Carbon Block Filter	5 Millionths of a Meter	Organic Chemicals, Sediment, Cysts
Granulated Activated Carbon	25 Millionths of a Meter	Organic Chemicals, Large Sediment
Ceramic Filter	0.9 Millionths of a Meter	Sediment, Cysts

Steam Distillation requires considerable energy to boil the water. The water and leaves behind mineral that must be cleaned from the distiller. Chemicals that volatilize and condense like water must be removed by carbon pre-filtration. Process produces water with nothing left but H2O.

Reverse Osmosis produces about 3 gallons waste water for every one of purified water. This water can be repurposed for watering of plantings and lawns.

Our Founder

Helmut Ziehe, 1936–2013



Helmut's Building Biology calling began with an "ah-ha" experience in North Africa in 1980 that changed the course of his life and career. As resident engineer for a city of 90,000 inhabitants, he noted that a majority of people had abandoned their government-provided homes in favor of living in tents. Their government homes were constructed of concrete, a poor material health-wise, that heated the interior rooms to an extent that air-conditioning could not bring adequate relief. A seasoned architect with a Dipl.Ing. degree from Technical University of Berlin, and a Master's in Tropical Studies from the London School of Architecture, Helmut unearthed the solution by examining historical local homes, some of which dated back 4,000 years, and found they used clay for their basic building material, as well as utilized covered walkways for shading and ventilation.

This eye-opening experience led Helmut beyond his career as a modernist architect to embrace the precepts of Baubiologie. Once his engineering assignment in North Africa was completed, he began his studies under Dr. Anton Schneider at the Institut für Baubiologie + Oekologei (IBN), and never thereafter returned to his "conventional" architecture practice. In 1985 he moved to the United Kingdom, where he established the English Institute of Baubiologie, personally translating from German into English twenty-three IBN course packs that became the IBE Correspondence Course for training new Building Biologists. In 1987, he relocated to Clearwater, Florida, establishing the International Institute for Baubiologie & Ecology, which to this day (as Building Biology Institute) serves all of North America, as well as English speaking students and alumni from sixteen (and counting) overseas nations.

In 1989, when a reporter asked Helmut, "How many students does the Institute have?" Helmut answered: "Only eight." To which the reporter replied: "Everyone has to start small." Since that day, the institute Helmut founded has enrolled over 2,000 students.