

# HAPPY HOUSE



A GUIDELINE FOR ARCHITECTS TO  
DESIGN WITH THE SENSES  
FOR A HEALTHY USER

# 01 SKIN - FEELING - THERMAL COMFORT

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How do you perceive a space with your skin? How does it feel? Cold, dry, warm, humid, chilly or windy? Thermal comfort is a main aspect of spatial quality. It protects and separates us from the climate outside and it is mainly defined through temperature, humidity and air drafts.

**HUMIDITY:** The humidity of an interior space should be between 40 and 60%. Natural materials with a high hygroscopicity, such as rammed earth, timber, clay- and lime plaster create a balanced humidity level, prevent condensation and therefore mold formation. A thin layer of 2-3cm already has a big impact on the interior climate (e.g. clay plaster on concrete).

**TEMPERATURE:** The temperature of an interior space should be around 18- 22°Celsius. Surface heating systems or tile stoves should be preferred against air heating systems. They save energy (6% heating energy for 1°C change in air temperature) and are closer to the natural radiant warmth of the sun. The thermal conductivity of floorings should be  $< 0.2\text{W/mK}$  (e.g. wood, cork, carpet or linoleum) so that they are warm to the feet. Combining insulating outer walls (10-20cm insulation: e.g. woodwool, soft fiberboards, sheepwool, hemp, flax, cellulose) with solid heat storing interior walls (min. 10-15cm: e.g. clay, bricks, stones) ensures a balanced temperature. Combining south-facing window areas with 4 times as much heat storing surfaces in the interior allows the use of passive solar gains and avoids summerly overheating. To control passive solar gains, south- and west facing windows should be equipped with shading options on the outside.

**AIR DRAFTS:** Crossventilation is important for a good air quality, to balance humidity levels and to cool spaces in hot climates. However, unless one wants to ventilate a room, air drafts should be avoided. An airtight building, the preference of surface heating systems and reasonable window sizes without glazing under the usual breastwork height avoid unpleasant air drafts.

## 02 NOSE - BREATHING - AIR QUALITY

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How does a space smell? How is its air quality? The most beautiful building is not enjoyable, if its air is musty, contains too much CO<sub>2</sub> or toxic irritants. The CO<sub>2</sub> level, biological molds, yeasts and bacteria, chemical toxins and fine particles are the biggest threats to a good interior air quality.

**CO<sub>2</sub>:** To ensure a good air quality the amount of CO<sub>2</sub> inside a space should stay below 0.07%. This requires 50M<sup>3</sup> of fresh air per person and hour for light activities and up to 100M<sup>3</sup> for heavy, physical activities. The options for crossventilations as well as the temperature- resp. air pressure- differences between in- and outside determine the necessary duration to exchange the air. Short, but intense, regular and manual crossventilation ensures a good air quality and prevents mold formation, while keeping the heat loss low.

**BIOLOGICAL MOLDS:** Molds, yeasts and bacteria occur in humid areas. They release toxic emissions harmful to the respiratory tract of humans. An uninterrupted, outer insulation, as well as an inner air tight layer avoid thermal bridges and thereby the occurrence of condensation and mold formation. Special attention must be given to humid areas, such as plants, kitchen- and bathroom appliances, air humidifiers, controlled ventilation systems and air conditioners. Filters need to be changed regularly.

**CHEMICAL TOXINS:** The avoidance of synthetic materials, such as adhesives, glues, paints, varnishings, OSB or MDF panels reduces the amount of pollutants, irritants and allergens. Instead, natural building materials should be used, which come along with a pleasant smell and a high sorption capacity to absorb odors and air pollutants (e.g. clay products, timber).

**FINE PARTICLES:** The avoidance of wall- and floor carpeting reduces the amount of fine particles and dust. The use of HEPA filters for vacuum cleaners and controlled ventilation systems is relevant for a further reduction.

## 03 TISSUE - RADIATION

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Probably the most difficult aspect to take into consideration is radiation, since it is hardly perceptible by humans. However, it has an increasing importance, as households are more and more filled with technology, which has a considerable impact on the human health.

**RADIOACTIVITY:** Materials that have been exposed to natural radiation in the atmosphere for a long time, can be radioactive, such as stones, ashes, slags, tiles or clay. Tests help to make sure, if these materials are radioactive. An additional focus must be given on a proper sealing of foundation slabs, since radon often accumulates under the foundation.

**ELECTRIC FIELDS:** Buildings should not be placed next to high voltage- or train-lines. The minimum safety distance from such lines in meters is equal to the voltage in kW. The power supply of a house should be underground. The bed- and livingroom should not be adjacent to the garage. Keep distance from inverters (>3m) and PV-modules (>2m), too. Use grounded plugs and shielded electric cables that are arranged in a star-like pattern instead of a loop. Integrate demand- or cut off-switches for bedrooms and plan installation-free living- and sleeping-zones/walls.

**ELECTROMAGNETIC FIELDS:** Steel components, adjustable office chairs, phone receiver, loudspeaker, innerspring or boxspring mattresses can greatly distort the Earth's magnetic field and should be used consciously.

**RADIOFREQUENCY:** Cordless phones, babyphones and microwaves should be used sparingly. Hardwired connections (LAN) should be preferred against WLAN. When not in use, smartphones should be in flightmode, cordless phones should be in eco-mode (if available) and in their base and WLAN should be turned off. This is especially important during the night to ensure a good and recovering sleep. Keep distance from antenna-towers.

## 04 EYES - SEEING - LIGHT QUALITY

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This is probably the most obvious way to perceive a space. Nevertheless, it should neither be overestimated by neglecting the other senses, nor should it be underestimated by only using it for aesthetic reasons and thereby forgetting the (natural) light's importance for daily life routines.

**SUN LIGHT:** Rooms should be organized according to their usage and daylight incidence. Sleeping rooms could be allocated in the east to wake up with the rising sun, offices, living- and dining rooms, where light activities take place or children play, should be oriented towards the south or west. Workshops, ateliers or bathrooms can make use of the diffuse light from the north. Natural daylight is effective to about 6 meters from the outer walls. The higher the position of the window, the deeper the light reaches into the room. Provide access to outside spaces such as terraces or balconies.

**ARTIFICIAL LIGHT:** Make use of flicker-free light and avoid dimmable light. Use light sources with a high color rendition (Ra value > 90) and adapt them to the natural daylight cycle (circadian rhythm), so that they are rather redish in the evening and rather white or blueish during the day. Do not save energy at the cost of a good interior light quality.

**COLORS:** Colors can have a decisive impact on the human health. Prefer rather bright, analogous, tone on tone colors, based on natural substances. Use dark, intense and complementary colors sparingly. Warm colors are suitable for bathrooms. Floors should be darker than walls and ceilings.

**SURFACES:** Natural materials do not only balance humidity differences and absorb unpleasant smells, but they also come along with a vivid expression. They should not be treated or only with natural finishes, such as clay plasters (inside), lime- or silicate plasters (outside), oils (intensively used timber floors and chairs) or waxes (less strained timber).

## 05 EARS - HEARING - NOISE CONTROL

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How does a space sound? This is not only relevant for concert halls and theatres, but for every interior space. Silence is a relevant factor for our health to recover from daily stress and enjoy a good sleep. Quiet areas should be part of a sustainable environment, like clean air and fresh water.

**SURROUNDING:** Neighborhoods should include mixed uses, bicycle- and pedestrian friendly streets and an easy access to public transport to reduce car traffic and thereby noise- and air-pollution. Noises from existing traffic can be reduced through vegetation and sound barrier walls.

**AIR BORNE SOUND:** Air borne sound insulation can be ensured through high density materials. In the case of lightweight structures, double wall assemblies with cavity insulation, as well as suspended ceilings help to compensate the lacking mass. Airtight windows and rather heavy and thick doors reduce sound bridges between different rooms and in- and outside.

**STRUCTURE BORNE SOUND:** Structure borne and impact sound bridges can be avoided through elastic separations between different structural parts, such as floors and walls, floors and ceilings (soft fiberboards with medium bulk density, mineral- or coconut fiber panels under floor screed), stairs and floors, plumbing fixtures (cork, felt), piping, and bathtubs.

**FLOORPLAN LAYOUT:** Noisy and quiet rooms should be separated and organized according to the surrounding; noisy rooms towards the street, quiet rooms towards the garden or courtyards. Sanitary installations and shafts should be concentrated and not located adjacent to quiet rooms.

**SOUND ABSORPTION:** Sound absorbing materials, such as curtains, carpets, rugs, partition walls, acoustic elements or upholstered furniture reduce sound levels up to 10dB and are helpful for subsequent improvements.

## 06 BODY - MOVEMENT - ERGONOMY

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Movement is a characterizing aspect that differentiates the perception of architecture from arts, such as painting or sculpture, where no or little movement is involved. It is also a decisive factor for an inclusive design by ensuring access for disabled and old people, as well as to prevent accidents.

**FURNITURE:** All furniture should support a natural position of the human body, especially the spine. The materials in contact with the skin should be breathable, natural and antistatic. Chairs and desks should be adjustable to the user's body and support dynamic sitting. Standing desks are a valuable addition in offices to reduce the sitting time. Beds should be oriented along the north-south axis with the head on the north side.

**ROOMS:** Kitchens should be organized to support an efficient workflow. The counter height should be adapted to the user's height and prevent her or him from bending unnecessarily. Often used appliances should be stored on an easily accessible height. Bathrooms and toilets should be separated to allow simultaneous usage. Consider harmonic forms and proportions.

**ACCESSIBILITY:** Avoid steps, pits or high thresholds and ensure even and grippy floors. Additional ramps ( $<6^\circ$ ) or elevators should guarantee access for disabled people. Enough moving space in bathrooms, around beds and furniture must be considered for people in wheelchairs (90x130cm). Doors should be 90cm wide.

**SAFETY:** Sharp edges should be avoided. The same counts for steps and high thresholds. All floors should be nonslip. Bath- and showertubs and other slippery surfaces should be equipped with nonslip mats. Railings must be at least 100cm high and prevent people from climbing them or falling through the divisions (gaps  $<12$ cm). Stairs should have an appropriate rise-to-tread ratio:  $2 \times \text{rise height} + \text{tread depth} = 63 \text{ cm}$

# HUMAN HEALTH AND ARCHITECTURE

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Including all the human senses in the design process does not only result in an enriched and stimulating spatial experience, but most of all promotes a healthy way of living. Without providing thermal comfort, fresh air, silence or daylight, even the visually most beautiful architecture would be useless.

When we talk about sustainable architecture, we often relate to energy efficiency. What we tend to forget is the aspect of the human health. People in western countries spend around 90% of their lives inside buildings, so that it seems to be worthwhile to have a closer look at the relation between architecture and the human health. In the end it is not just a big layer of insulation and a roof covered with PV that will be appreciated and therefore maintained for many years, but a house that contains a healthy and happy inhabitant.

This booklet provides an understanding of architecture through the senses. How do we perceive a space with our skin, nose, eyes, ears or the movement of our body? This multisensory approach evokes different priorities in comparison to the often visually guided perception of architecture. In a nutshell, the use of locally available and natural building materials, carefully applied according to their characteristics and in harmony with the natural and built surrounding results in a multisensory, pleasing, spatial experience and has a good impact on the human health.

However, this booklet can only provide a summary about the integration of human health into the design process. For more information about a holistic understanding of sustainable architecture that includes the human health, as well as energy efficient building methods, you should get in contact with a building biologist or the Institute for Building Biology and Sustainability IBN in Rosenheim (DE), which also provides (distance) learning courses.

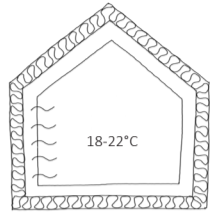




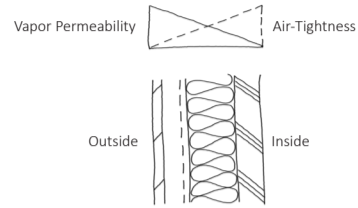
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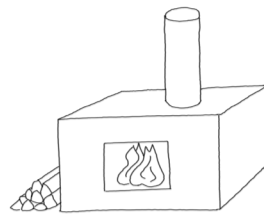
## 01 THERMAL COMFORT



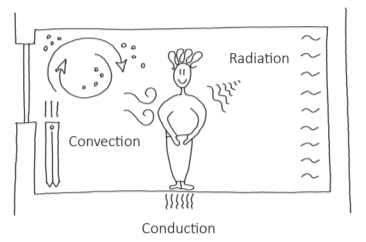
Combine an insulating outer layer with heat storing inner walls...



...avoid condensation through airtight, but vapor permeable walls...

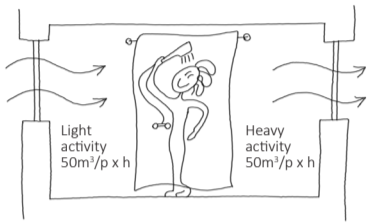


...prefer tile stoves or surface heating systems against air heating systems...

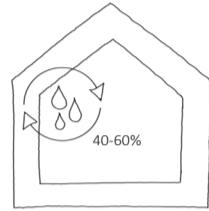


...to save energy, to avoid circulating dust and to keep the feet warm.

## 02 AIR QUALITY



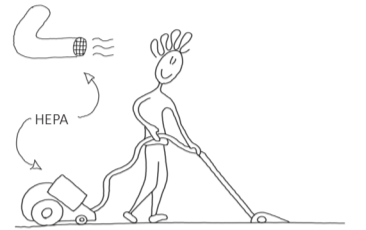
Ensure regular, short, but intense (cross)ventilation...



...use natural humidity buffering materials with a pleasant smell...

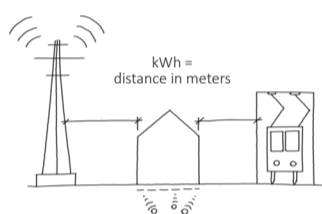


...do not use adhesives, glues, paints, varnishes, OSB or MDF panels...

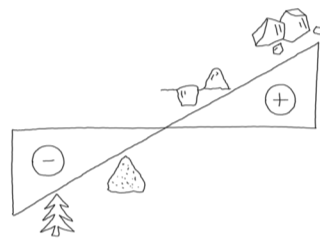


...avoid carpets and use HEPA filters to reduce the amount of fine particles.

## 03 RADIATION



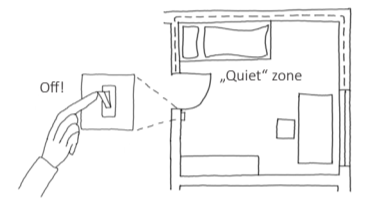
Keep distance from high voltage-lines and seal the foundation...



...test possibly radioactive materials, such as stones or clay...

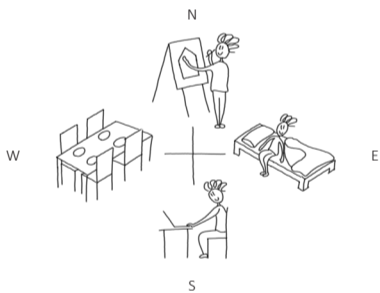


...use cordless appliances, microwaves or babyphones sparingly...

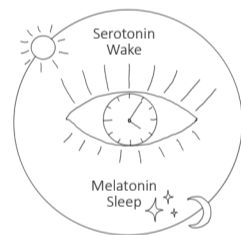


...plan demand switches and integrate installation-free zones/walls.

## 04 LIGHT QUALITY



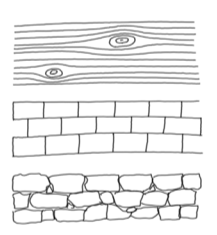
Organize rooms according to the sunlight incidence...



...adapt artificial light to the natural daylight cycle...



...do not only think in black and white...

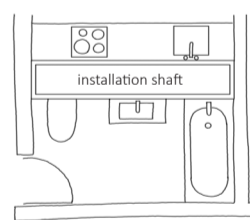


...but make use of the vivid expression of natural materials.

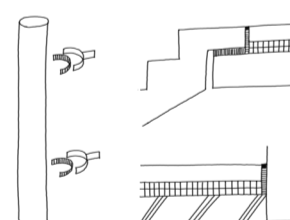
## 05 NOISE CONTROL



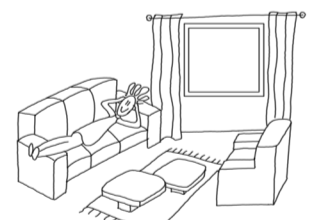
Plan mixed use, walkable and therefore quiet neighborhoods...



...concentrate sanitary installations...



...separate structural parts through elastic materials...

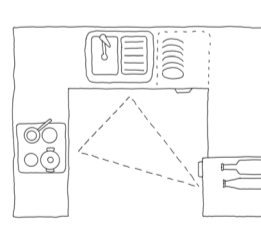


...and reduce high sound pressure through sound absorbing materials.

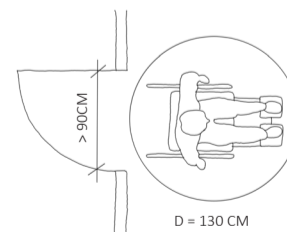
## 06 ERGONOMY



Support natural body positions through harmonious proportions...



...simplify daily life routines and allow efficient workflows...

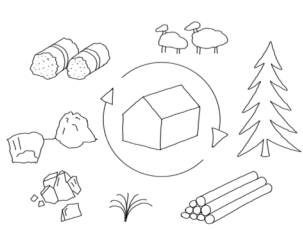


...make your design accessible for everyone...



...and minimize the risks of accidents.

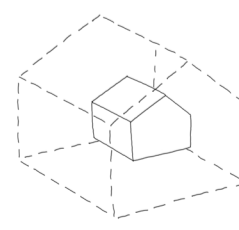
## 07 IN GENERAL



Use renewable, natural and locally available resources...



...relate to and support local traditions and craftsmanship...



...always question your needs, only build as much as necessary...



...and build in harmony with the natural and built surrounding.