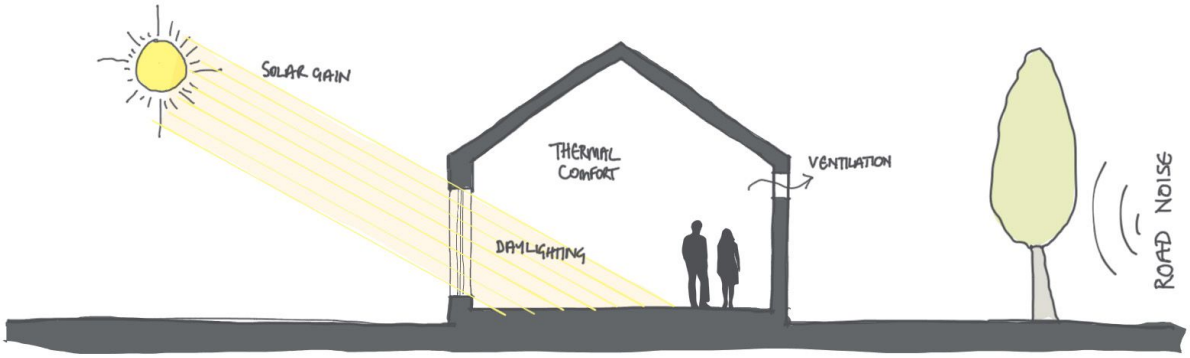
INTERNAL ENVIRONMENT THERMAL, AIR, SOUND & LIGHT

From FIRST IN ARCHITECTURE

Internal Environment

Some of the key factors requiring improvement for the sake of the internal environment of our buildings include thermal performance of the fabric of the building and an improved response to our changing climate. As our climate continues to change, it is more likely that occupants will suffer temperature related health issues so it is vital our design considers in detail issues such as thermal comfort, ventilation, daylighting, solar gain and solar shading from an early stage in the design process.



Thermal Comfort

Thermal comfort is linked to a feeling of well being of an occupant. If there is a high level of well being, a high performance level can be expected in a work environment.

Thermal comfort can vary from person to person, and has many contributing factors. Our bodies are constantly producing heat energy from the food we consume, which is dissipated in the form of convection, radiation and evaporation in order to keep our bodies at a constant temperature. Our heat production can depend on our size, our age, our sex, the activity we are carrying out and the clothes we are wearing.

Thermal comfort can be affected by factors, some of which are personal to us, while others relate to the conditions around us.

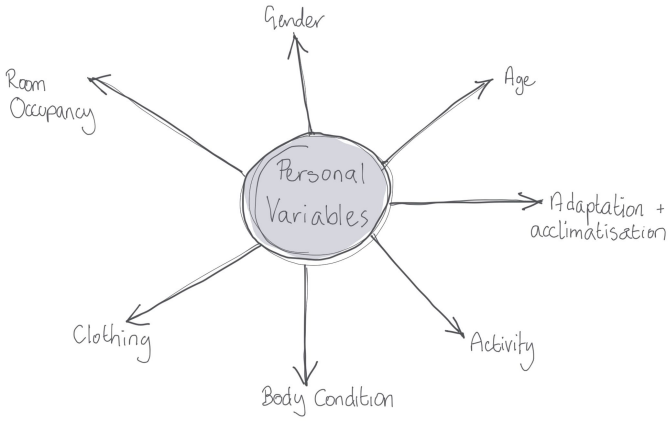
Personal variables:

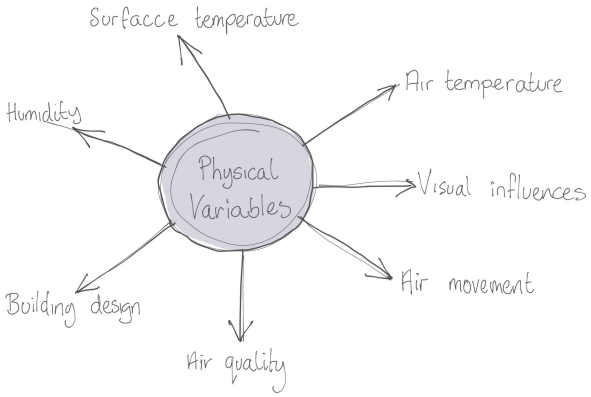
- Activity
- Age
- Gender

- Clothing
- Adaptation and acclimatisation
- Room occupancy
- Body condition

Physical variables:

- Air temperature
- Air movement
- Surface temperature
- Humidity
- Building design
- Air quality
- Visual influences





Activity – the greater the activity level, the more heat our body will emit. The rate this heat emits will depend on the metabolic rate and surface area of the individual.

Typical heat output of human body

Activity	Example	Typical heat emission of adult male
Immobile	Sleeping	70W
Seated	Watching television	115W
Light work	Office	140W
Medium work	Factory	265W
Heavy work	Lifting	440W

[Table adapted from Environmental Science in Building – Randall McMullan]

Clothing – helps us maintain a more constant body temperature by providing a thermal insulator. We wear varied clothing at different times of the year and our buildings must be adaptable to provide comfortable temperatures for these variables.

Air temperature – both the temperature of the air, and the temperature of the surrounding surfaces can have an impact on our thermal comfort. Temperature tends to be the most decisive factor of an occupants thermal comfort. This can depend on mood, duration of stay and so on.

Air movement – Air movement helps increase the heat lost from the body by convection, and can give the sensation of draughts. On a warm day this can be very pleasant, but on a cold day a draught can be very uncomfortable. Thermal discomfort tends to be experienced more when there is a draught when the occupant is sitting, so when people are sitting in an office, school or conference type settings it is important to minimise the feeling of air velocity (draught). Natural draughts can occur near windows or in rooms with high ceilings.

Humidity – The ideal relative humidity range is between 40 and 65% for comfortable conditions. High humidity with high temperatures can lead to an oppressive feel, and decrease the ability to naturally cool by perspiration. High humidity can also lead to mould growth which can aggravate asthma and allergies.

Extreme thermal discomfort can lead to thermal stress, which occurs during particularly hot summers or even moderate winters. Factors such as draughts, high relative humidity and cold temperatures from poor heating can lead to thermal stress, which causes a number of medical conditions. Thermal stress is more common in the elderly, very young or infirm.
Some key considerations when designing for thermal comfort:

- Ideal internal temperatures in winter: 18-21˚C
- Ideal internal temperatures in summer: 22-27˚C
- Occupants can experience thermal discomfort when the temperature at foot level is below 19˚C, or 3˚C below head level. This can be alleviated with underfloor heating.
- Ensure relative humidity (RH) is between the comfortable levels of 40%-65%
- To avoid high levels of CO2 concentrations, ensure there is suitable ventilation to keep concentrations below 1000-1200ppm.
- Use Mechanical Extract Ventilation (MEV) or Mechanical Ventilation with Heat Recovery (MVHR) to create good air quality in winter
- Allow users to operate elements to achieve improved thermal comfort – for example blinds, window openings, adjusting the heating and cooling.

- Do internal spaces respond to the sun path?
- Is there natural purge ventilation for cooling?
- Is there sufficient year round background ventilation?
- Is daylight maximised by providing a shallow plan?
- Is there good night cooling (especially in thermal mass designs)?
- Is solar shading provided (horizontal on the south and vertical on the east and west)?
- Are all heating, cooling and solar shading systems easy to control and maintain?

[Reference: Environmental Design Pocketbook – Sofie Pelsmakers]

Optimising thermal comfort should be woven into the general architectural design process, with the tips above proving a useful checklist to get you started. In future articles we will study the requirements for optimal thermal comfort in more depth.

Air Quality

Optimal air quality is another vital consideration during building design. Not only do humans need air to breathe and live, the quality of air in our buildings whilst at home, at school, at work or during recreational activities also has an impact on our feeling of well being. Poor air quality can result in people suffering from a number of ailments including skin irritations, headaches, tiredness and general feelings of being unwell.

Air quality requirements will vary according to the different activities carried out in the space, number of people and the length of stay in that space, amongst other factors. It is also worth noting that outside air quality will have an impact on the type of ventilation specified.

Human emissions also contribute to the interior air quality, along with emissions from materials in the room. Any materials that have a negative impact on air quality should not be specified.

Both mechanical and natural ventilation can be used to provide consistent clean air to a building, and usually a combination of both of these works well.

Ventilation in buildings has a number of objectives including:

- supply of oxygen for human breathing
- removal of carbon dioxide from human breathing
- control of humidity for human comfort
- control of air velocity for human comfort
- removal of odours
- removal of micro-organisms, mites, moulds etc.
- removal of excessive heat
- removal of water vapour to help prevent condensation issues
- removal of particles such as dust and smoke
- removal of volatile organic compounds (VOCs) from cleaning solvents, carpet, furniture and building products
- removal of ozone gas from photocopiers and laser printers
- removal of cooking and heating combustion products

[reference Environmental Science in Building – Randall McMullan]

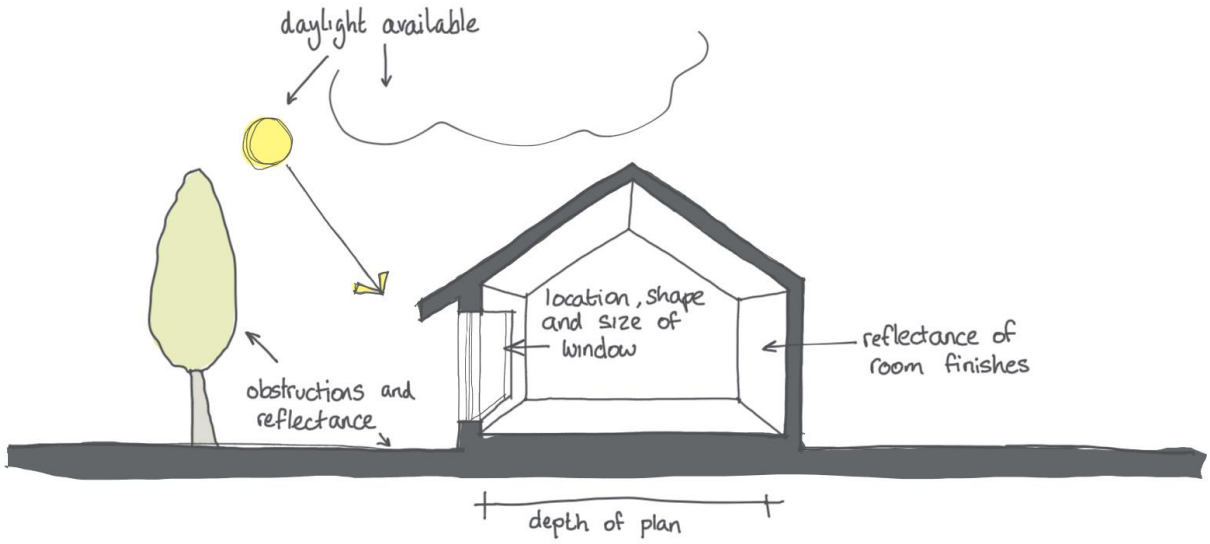
Light

Achieving visual comfort in a building is usually a combination of both natural daylight and artificial lighting. Designs should attempt to include a good amount of natural daylight without risking summer overheating.

Daylight enters a building through skylights or windows, but these windows can also transmit heat, sound and air. It is therefore important to consider natural lighting along with all the other environmental variables.

Daylighting depends on:

- the amount of daylight available
- any obstructions or reflectance
- internal reflectance of room finishes
- location shape and size of the window
- depth of the plan of the room



The selection and specification of artificial lighting will be designed in conjunction with other environmental factors such as daylighting and window openings, heating and cooling, extent of the plan, use of the building and so on.

The main functions for artificial lighting are:
Task – lighting to help building occupants to carry out specific activities
Movement – lighting to allow the building occupants to move safely around the building
Display – lighting to illuminate a particular feature of the building or particular element within the building

Acoustics

Sound can have an impact on our physical and mental well being. Surveys have indicated that 50% of people find their home in some way unsatisfactory because of noise intrusion – this includes people living in new homes built to modern building standards. It is an important consideration when designing buildings that we consider the sound quality of our built environment. Unwanted sound is perceived as a nuisance and can cause a number of emotional effects.

The primary noise intrusion is outside noises, particularly traffic both in permanent noise levels (a busy road), and short term, (passing airplane, train etc). Outside noise levels can influence levels of concentration, work performance and interrupt our rest or sleep.

A factor to consider when designing ventilation strategies is the opening of windows in warm temperatures and whether this activity will be impacted by external noise levels. Reports

indicate that occupants are more willing to accept higher levels of noise from outside for the sake of natural ventilation through windows on a warm day.

Other noise sources can include industrial noise, construction noise and noise from leisure and entertaining. Inside buildings we can experience noise issues from other occupants, machinery and appliances and so on. It is also worth noting some activities require specialist sound design, for example recording studios.

Example of sound levels

Sound level dB	Typical enviornment
140	Threshold of pain
130	Aircraft take off
120	
110	Loud discotheque
100	Noisy factory
90	Heavy lorry
80	High street corner
70	Vacuum cleaner
60	Normal conversation
50	
40	Suburban living room
30	
20	Quiet contryside
10	
0	Threshold of hearing

[Reference Environmental Science in Building – Randall McMullan]

The following articles will study some of the design requirements for the many different internal environment factors in more detail.

References:

Environmental Science in Building – McMullan
The Environmental Design Pocket Book – Pelsmakers
Green Building – Guidebook for Sustainable Architecture – Bauer, Mosle, Schwarz

Read the original post here:

https://www.firstinarchitecture.co.uk/internal-environment-thermal-air-sound-and-light/

You might also be interested in:

Building Fabric 01 - Thermal Performance