AUTEX
FUTURE LAB

Healthy materials: their role in our health and wellbeing

HOW HEALTHY MATERIALS CAN PROMOTE WELLBEING THROUGH REGULATING THE INDOOR AIR QUALITY AND SENSORY ENVIRONMENT

Contents

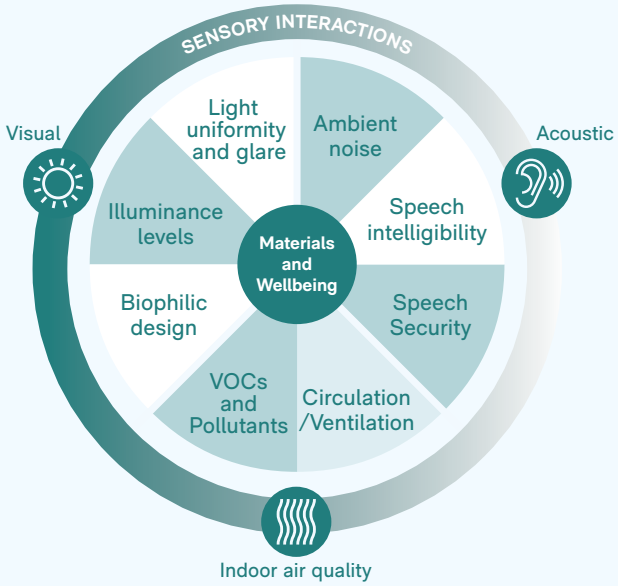
Globally, buildings are responsible for the consumption of a vast share of resources and over a third of the world's total CO_2 emissions[1]. With the rapid increase of the human population and the accompanying land urbanisation, the building industry is being presented with the unique opportunity to not only minimise its impact on the environment, but to actively promote public health and wellbeing.

The convergence of building and health science has produced a strong body of evidence showing the direct effect a building has on the health of its occupants. Research shows that healthy indoor environments can improve mood and cognitive abilities[2] —however, in Europe, as many as one in six people still live in homes that make them sick[3].

Viewed as the next iteration of the green building movement, healthy buildings address these issues through incorporating health-led integrated design—which not only includes resource-efficient and sustainable design, but promotes health and wellbeing by addressing core concepts including ventilation, lighting and views, air and water quality, temperature, noise, moisture, dusts and pests, and safety and security[4].

While the design of healthier environments has often focused on space programming, daylight and views, building materials are increasingly receiving attention. Effective materials selection can prevent the emission of indoor air pollutants leading to a poor indoor air quality[5]. The application of appropriate materials can also regulate the way occupants are influenced by the multisensory dimensions of the environment, particularly the visual and acoustic elements of a space.

This report outlines the benefits of healthy buildings to the health, wellbeing and productivity of occupants, and the resulting benefits to business. It details how noise, lighting and indoor air quality contribute to health and wellbeing through the specification of healthy materials, and touches on certification to the WELL standard.



The benefits of a healthy building

Wellbeing

As illustrated by the growth of the wellness industry to an economy currently valued at $4.5trillion[6], our standards of health are changing. More than just the absence of disease, the definition of health according to the World Health Organisation (WHO) encompasses the cultivation of physical, mental and social wellbeing[7].

Healthy buildings must not only protect occupants' health, but incorporate features that accommodate and enhance each of these key aspects of physical health, as well as mental and social wellbeing.

The following features can be implemented to contribute to improving each health outcome.

Physical health

Air quality management reduces our susceptibility to illness, particularly cardiovascular and respiratory disease[8] Breathing Volatile Organic Compounds (VOCs) and other pollutants in the air can irritate the eyes, nose and throat, cause difficulty breathing and nausea, and can damage the central nervous system and other organs. Some VOCs are known carcinogens, and exposure to higher concentrations may cause irritation of the lungs, as well as damage to the liver, kidney, or central nervous system. Physical health can be supported by controlling indoor air quality, as well as indoor sensory stimuli—namely light and sound—to produce a comfortable sensory environment. Good lighting leads to better sleep at night which plays an important role in the proper physiological functioning[9], as well as helping to maintain eye health. An uncomfortable acoustic environment and uncontrolled noise can cause hearing impairment, and has been linked to higher systolic and diastolic blood pressure and changes in heart rate[10].

Psychological wellbeing and productivity

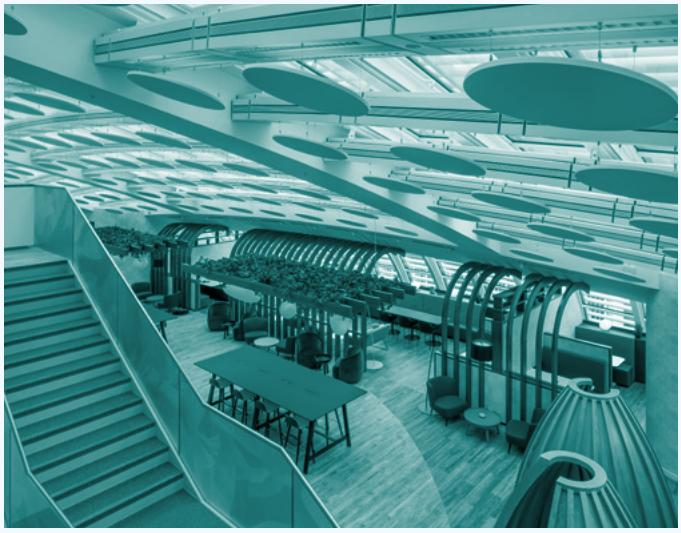
Unhealthy buildings can impair mental health, with one in five English adults reporting that a housing issue has negatively impacted their mental health in the last 5 years[11]. Constructing buildings with low VOC materials, lighting and noise control improves productivity during the day while promoting better sleep—which is essential for cognitive function. Exposure to environmental noise can impair performance and productivity, particularly during complex tasks. Multiple studies show the detrimental impact of background speech on the performance of semantic tasks such as comprehensive reading, proof reading and writing, while a survey of more than 1,200 senior executives and employees found that 53 percent reported ambient noise reduced their work satisfaction and productivity[12]. The control of noise and light in order to improve sleep is just as important to mental health as physical health. Alongside preventing conditions associated with poor sleep including anxiety and depression, well-regulated lighting and acoustics can boost mood and performance.

Organisational performance

The benefits of healthy buildings in improving physical, psychological and social wellbeing extend beyond the individual. A reduction in employee absenteeism, lowered healthcare and insurance costs, and a reduction in compensation claims[13] are just some of the financial incentives for proactively improving employee health outcomes. Ultimately, healthy occupants translate to a healthy bottom line, not only through mitigating operational costs, but through fostering wellbeing which, in turn, enhances performance on an individual and organisational scale.
Acquiring and retaining quality talent is essential for improved business performance, and healthy buildings offer a win-win value proposition as a HR tool in themselves—capable of both attracting prospective employees and boosting job satisfaction and wellbeing, leading to retention of the best talent.

Investment in the future

The business case of healthy buildings extends beyond the present, as building owners are increasingly seeing the returns of their healthy



building investments. Of the property asset owners that measure the impact of their investments, 73 per cent report faster leasing rates and 62 per cent report higher asset values.

Investing in materials and design to create healthy spaces not only affects the bottom line today but ensures a future-proof asset in the growing healthy-building movement.

Achieving Health and Wellbeing

With the knowledge that healthy building design can enhance quality of life and provide a substantial ROI, this report will now explore the strategy of implementing features that are conducive to a healthy building. While the approach to creating healthy spaces includes a variety of design considerations, the specification of the right materials can significantly contribute to achieving the fundamentals of healthy environments, and will be discussed in relation to providing sensory comfort through acoustic and visual control as well as improved indoor air quality.

Acoustics and comfort

WHAT ARE THE EFFECTS OF AN UNCONTROLLED ACOUSTIC ENVIRONMENT?

Just as we see a spectrum of light, we hear across a range of octave bands. Sounds are made from a wide array of signals at varying volumes and frequencies, which can exert influence on our wellbeing and performance through a number of distinct routes[15]. Noise, characterised as unwanted sound, acts on the central and autonomous nervous system by means of sound waves which are channelled and amplified in the ear. When a stimulus exceeds a certain limit, pathological affects are incurred. Even at volumes significantly below this limit, noise can produce negative effects[16]. Noise can be internally generated through electronics, mechanical equipment and other noise-emitting devices, the building occupants themselves, and exterior sources such as traffic and aircraft noise.

Sound reaches the listener both directly from the source and via sound reflections from surfaces. A build-up of reflections creates a reverberation which persists after the cessation of the original signal, until it is absorbed by the surfaces of objects in the space. Reflected sounds can build up to a level that is louder than the direct sound, eventually masking the original signal. In addition, the late arriving sound reflections can smear the direct sound signal leading to a further reduction in auditory quality. The result of this sound masking is reduced speech comprehension as well as cognitive fatigue from the effort required to process distorted auditory information[17]. When confronting reverberation and sound masking people often speak up in order to be heard, creating the potential for vocal strain while adding to the reverberation and compounding the acoustic issues.

Through its effect on attention and potential to cause distraction, noise not only hinders the mental processing of auditory information, but also impacts tasks such as reading and writing. Through its effect on brain stimulation, noise also disturbs sleep—reducing overall health and wellbeing. It is particularly important to maintain noise within defined parameters as detrimental effects do not require prolonged exposure, or exposure to high volumes, to be incurred. Table 1 shows our perception of different levels of sound in decibels. As decibels are on a logarithmic scale, just a small change in decibels will incur a big difference in our perception. For example, the difference between a normal conversation taking place (60 dB) and a group activity in an open plan space (70 dB) is 10 dB, however, we perceive the group activity being two times as loud.

Source	Level in dB	Difference
Jet engine at 25m	140	Damage to auditory system likely
Racing Cars (F1)	130	Painful
Chain Saw	120	32 times as loud as 70 dB
Pop Rock Concert	110	16 times as loud as 70 dB
Industrial Workshop	100	8 times as loud as 70 dB
Power tools / Hair dryers	90	4 times as loud as 70 dB
Sports Hall (in use)	85	LAeq (dB) 8hr OHS Limit
Shouting	80	2 times as loud as 70 dB
Open Plan - Group activities and Loud conversation	70	Max. recommended occupied noise levels **Base of comparison**
Normal conversation	60	Half as loud as 70 dB - Fairly quiet
Quiet office / Library	40	One-eighth as loud as 70 dB
Whispering	30	One-sixteenth as loud as 70 dB - Very quiet
Rustling Leaves / Mosquito	20	Faint sounds
Normal breathing	10	Faint sounds
Hearing threshold	0	Faint sounds

Table 1 – the difference in the level of decibels (dB) of various sources and their perceived loudness. This illustrates the effect of the level of sound in decibels which increase logarithmically on our perception of the loudness of those sounds.

Speech privacy

Another significant cause of acoustic dissatisfaction is overhearing private conversations and not being able to communicate securely. Of more than 25,000 workers surveyed by the Centre for the Built Environment at UC Berkeley, speech privacy was the environmental factor they were most dissatisfied with[18]. Acoustic privacy is important for a number of reasons, including confidentiality of sensitive information and the perception of privacy, which can be particularly important for external client meeting spaces.

How can we achieve acoustic comfort?

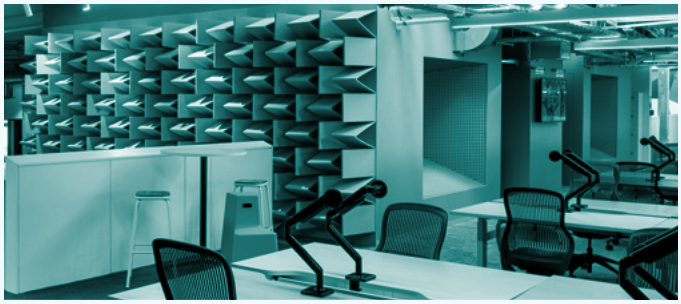
Acoustic comfort, defined as 'the perceived state of wellbeing and satisfaction with the acoustic conditions,'[19] is achieved when the environment controls noise that invokes adverse effects and facilitates effective communication and speech privacy.

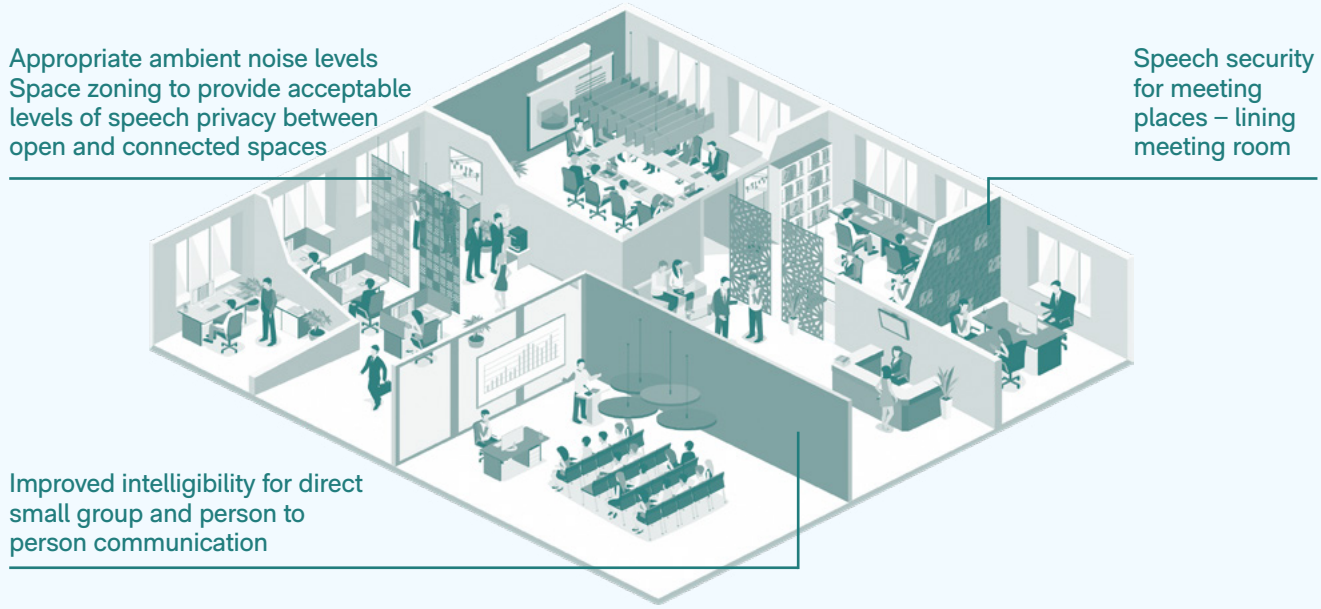
Performance requirements for acoustic comfort

In order to achieve acoustic comfort, the following performance requirements must be met:

- Design for appropriate ambient noise levels.
- Improved intelligibility for direct small group and person to person communication.
- Speech security for meeting spaces; in-person meetings and equally for audio-video conferencing.
- Space zoning to provide acceptable levels of speech privacy between open and connected spaces.

A sound pressure range from 35 to 40 dB has been identified as a neutral ambient level in an unoccupied office space[20]. For spaces where high speech intelligibility is required, such as schools and university lecture theatres, a signal to noise ratio of 10 dB is recommended by several building standards, including BS5839-8, BSEN 50849 and BS6259, where the ambient background noise is at maximum half the volume of the information being transmitted. To limit the ambient noise caused by reverberation, a maximum of 0.6 seconds reverberation time, or RT60, is specified for conference rooms by WELL standards for comfort[21], and 0.5 seconds for open workspaces. For learning spaces, an RT60 of either 0.6s or 0.7s for spaces smaller or larger than 10,000ft3, respectively, is deemed acceptable (WELL, Feature 78).
Through careful detailing of high-quality acoustic materials, sound transmission between adjacent spaces can be reduced by enhancing the abilities of interior partitions or doors to act as sound barriers. Appropriate zoning and acoustic treatment between open and connected spaces provides acceptable levels of speech privacy while controlling for unwanted loss of speech comprehension.





Meeting the acoustic requirements of the environment

The performance requirements for acoustic comfort can be met through selecting sound reduction treatments that incorporate absorptive surfaces, including wall panels, ceiling tiles and baffles, acoustic insulation, and surface enhancements. Acoustic materials help with reverberation management, control of ambient noise, speech intelligibility and privacy, and reduction of transmission between adjacent spaces.
Acoustic material has many applications and can be specified to meet the unique requirements of an environment and the zones within the space.

- For environments requiring high intensity acoustic treatment, such as large open spaces or places where speech intelligibility is particularly important, an increased area of noise absorbing surfaces, or a higher sound absorption coefficient can achieve acoustic comfort through reducing the ambient noise and reverberation time.
- The selective absorption properties of acoustic material can reduce the noise types that are least desirable, such as low frequency external sound intrusion or higher frequency sounds from conversation and talking.
- Depending on the layout of a space, materials can be positioned in a way that reduces noise travelling to other zones and adjacent spaces, such as down corridors and between meeting rooms, and prevents echoes from cross reflections. Sound barriers such as doors and partitions can be reinforced to enhance their effect on transmission loss between zones.
- Spaces that require high levels of speech security should be at a distance from quiet zones and the design of the building and acoustic treatment should support low levels of noise transmission.

Key points

Noise can influence health and wellbeing in a number of ways including being exposed to sounds that are too loud for too long, or through the effect of low quality sound transmission.

Appropriate ambient noise levels, space zoning, improved speech intelligibility, and speech security are key requirements for acoustic comfort which can be achieved through specifying acoustic materials that support these needs.

The positioning, noise absorption coefficient, and selective absorption properties of acoustic materials can be varied in order to meet the unique acoustic requirements of an environment and achieve acoustic comfort.

Lighting and visual comfort

WHAT IS MEANT BY VISUAL COMFORT? HOW DO WE MEASURE IT?

Visual comfort is defined by the European Standard EN12665 as a subjective condition of wellbeing induced by the visual environment'. The amount of light, quality of colours, uniformity of the light, and the risk of glare are some of the main factors in experiencing visual comfort. Along with these factors, criteria for the evaluation of visual comfort in BREEAM and LEED building standards include controllability of light, access to exterior views, daylighting and zoning[22]. Good lighting can promote eye health, enhance mood, contribute to overall wellbeing, and increase the desirability of a space[23].

Some of the common ways to improve visual comfort in an office environment include providing natural lighting and outside views of nature. However, lighting needs to be regulated in a way that provides optimum brightness levels with evenly distributed light and minimal glare. Glare can either come directly from the source or be reflected, causing the loss of visual performance, or discomfort due to a greater intensity of light in the visual field, compared to the intensity to which they are adapted. Glare can present an annoyance and distraction, leading to eye fatigue. The quality of daylight in an indoor environment depends, in part, on ensuring that glare is properly controlled.

Controlling glare

The level of glare in a space is quantified by the Unified Glare Rating (UGR); the higher the UGR is, the higher the level of visual discomfort. The WELL standard for lighting recommends a maximum UGR of 19 for industrial spaces and 16 for non-industrial spaces, such as office and commercial spaces.[24]

UGR can be controlled using several strategies, including proper positioning and tilting of light fittings, limiting the brightness of luminaires, and enhancing background luminance through having higher reflectance values for interior surfaces. Ceilings are recommended to have the highest reflectance values, which is achieved by specifying lighter colours, followed by walls and the floors.

Improving visual comfort through biophilic design

Another strategy to improve the visual comfort of a space is through biophilic design. The concept of biophilic design reconciles our innate need to associate with nature with the fact that most of our time is spent indoors through incorporating natural elements into the built environment.

> Connection to nature has profound benefits in engaging our senses and supporting emotional wellbeing: reduced cortisol levels (a marker of our body's stress response), increased kindness, improved learning engagement, and increased social connectivity.[25]

Experiences of nature

Biophilic design can be integrated in interior spaces through direct experiences of nature; this can include design features from using plants for interior decorations, to adding water features or whole ecosystems such as ponds and green roofs.

Perhaps less well known is the effectiveness of indirect experiences of the natural world. This includes images of nature and representational expressions, or incorporating natural materials such as stone and wool. Muted earth tone colours characteristic of soil, rock, and plants provide an indirect experience of nature when used in interior surfaces[26].
Shapes and forms inspired by the natural world can also effectively bring nature indoors, such as patterns like spirals, waves, stripes or symmetries reflecting those often found in nature. Through providing visual diversity with different shapes, colours, prints, patterns and designs of indoor materials, the interior can reproduce some of the diversity and information richness of the natural world. Art and design that celebrates culture and identity can foster a connection to the community, evoking thoughts, feelings, memories and emotional attachments to a place.

Versatile products for visual comfort

The surface area of specified acoustic treatments provides a rich canvas for incorporating biophilic design features representative of cultural art and nature, through printing, etching or sculpting the material and other customisations. The reflectance value of acoustic materials can be selected according to colour, with lighter colours offering higher reflectance. Available in a range of tones and natural colours, acoustic materials offer a multifunctional solution to reducing glare and improving light distribution in addition to achieving acoustic comfort.

Key points

Biophilic design enhances wellbeing through enhancing connectedness to nature and place. This can be done through expressions of nature, culture, art and community using interior materials.
Visual comfort can be improved through providing natural and well distributed light. Glare needs to be controlled, particularly during periods of peak exterior brightness. This can be achieved by proper fixing of light fittings, limiting luminance of each light source, and choosing lighter colour interior materials for higher reflectance to reduce the UGR and improve light uniformity.

Indoor air quality

WE BREATHE IN 15,000 LITRES OF AIR EVERY DAY.

Given that most people spend about 90 percent of their time indoors, and many chemicals used in construction now appear regularly in urine and blood samples, there is growing belief that our buildings are exposing us to hazardous chemicals[27].

"The true burden of environmentally induced cancer has been grossly underestimated. With nearly 80,000 chemicals on the market in the United States, many of which are used by millions of Americans in their daily lives and are un-studied or under-studied and largely unregulated, exposure to potential environmental carcinogens is widespread."

– President's Cancer Panel, 2010[28]

Despite a developing body of literature showing the risks that many of these chemicals pose to human and environmental health, and associated updates made to the law in 2016, the majority of these 62,000 chemicals have yet to undergo testing and continue to be commercially available[29].

VOCs: their sources and effects

Volatile Organic Compounds (VOCs) are emitted as gases from certain solids or liquids. VOCs include a variety of chemicals, some of which may have short and long-term adverse effects on our health.

VOCs are emitted by a wide array of products, numbering in the thousands. Many products found in the office environment may have the potential to release VOCs.

Examples include:

- Caulks, sealants, and coatings
- Adhesives
- Paints, varnishes and/or stains
- Wall coverings
- Cleaning agents
- Fuels and combustion products
- Carpeting
- Vinyl flooring
- Fabric materials and furnishings
- Air fresheners and other scented products
- Personal products of employees like perfume, shampoos, etc.

If these and other chemical contaminant sources are not controlled, indoor environmental quality problems can arise—even if the building's ventilation system is properly designed and well maintained. Concentrations of many VOCs are consistently higher indoors (up to ten times higher) than outdoors,

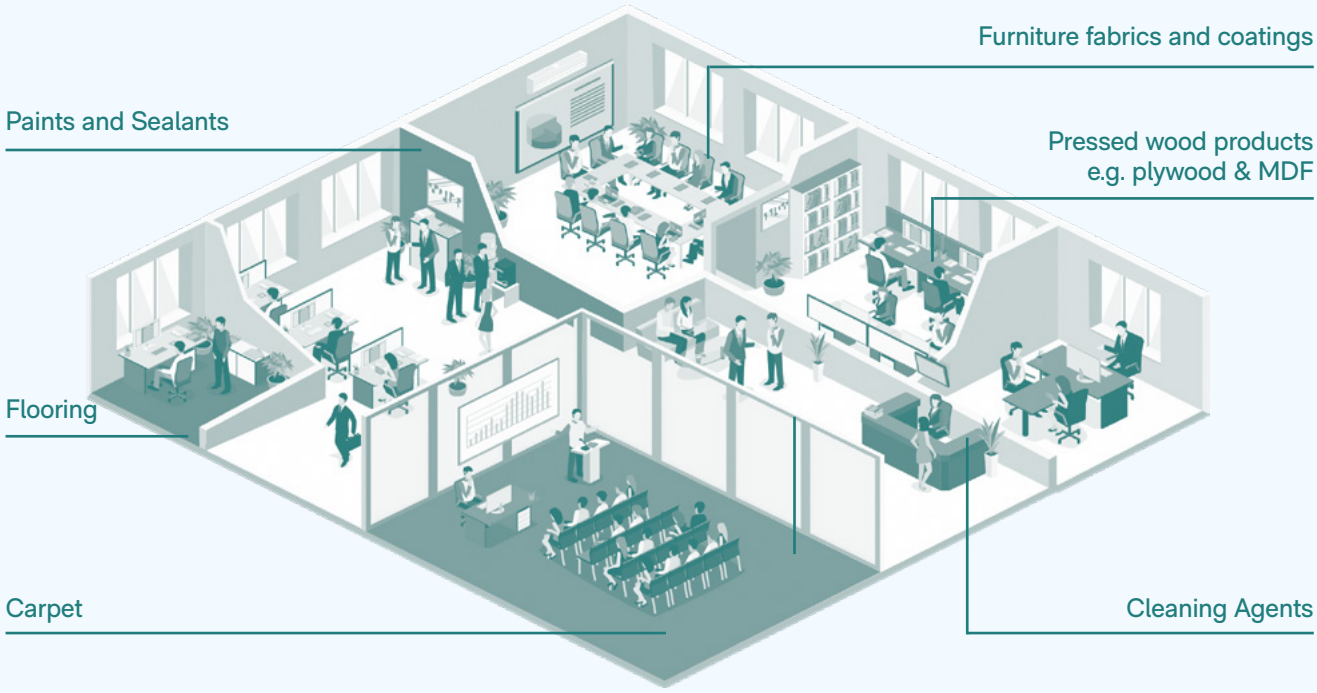
and, like uncontrolled lighting and acoustics, VOCs released from office furniture, carpets, and desks may be dulling our minds at work.

A well cited study in 2015 looked at office workers who were exposed to various concentrations of carbon dioxide and VOCs in a mock workplace. The study found that, when workers were exposed to higher levels, their cognitive functioning scores dropped[30]. The leading researcher of the study, Joseph Allen, says, "What we saw were these striking, really quite dramatic impacts on decision-making performance, when all we did was make a few minor adjustments to the air quality in the building." "Importantly, this was not a study of unique, exotic conditions. It was a study of conditions that could be obtained in most buildings, if not all."

Better indoor air quality, such as low levels of CO2, pollutants and increased ventilation, can lead to a marked improvement in productivity, contribute to creating heathy buildings, and increase occupant's health and wellbeing.

Studies show employees who work in buildings with high quality air circulating are healthier and more productive than those in poorly ventilated spaces.

Low VOC, high-ventilation and fresh air distribution can improve cognitive function by as much as 101%[31]. Employees in green-certified buildings scored 26.4 percent higher on the cognitive tasks than those in non-certified buildings, valued by one 2015 study as an equivalent of a $6,500 increase in productivity for a cost of less than $40 per person per year[32].



Interventions against poor IAQ

In the absence of robust toxicity information, many environmental health scientists and policymakers promote the Precautionary Principle, which encourages decision makers to exercise caution while awaiting absolute scientific proof of chemical health and safety.
A strong and growing body of research is showing that some of the most effective interventions for enhancing the health, productivity and wellbeing of people in the built environment is through healthier building materials and products. Improving the quality of indoor air generally relies on the use of a handful of basic strategies. The most generally effective and energy-efficient way to improve indoor air quality is through source control efforts, including the use of products that have been designed and constructed to reduce the emission of VOCs.
In a 2011 study[33], scientists at Lawrence Berkeley National Laboratory and the Environmental Protection Agency examined costs and benefits of improving indoor air quality in office buildings. The findings suggested that better air quality led to "increased work performance, reduced Sick Building Syndrome symptoms, reduced absence, and improved thermal comfort for millions of office workers." A further Harvard study from 2015[34] suggests that even spending less than $40 per person per year on indoor air quality can increase employee productivity by $6500.
We are now seeing companies getting serious about these topics and investing a good deal of money and time into improving their workspaces to optimize employee health.

Transparency in selecting healthier products

Transparency stems from the idea that knowing what is in our products is a necessary first step toward making more informed decisions about the materials we use, especially around how materials impact human health and wellbeing. The EPA advocates the most important strategy for the acceleration of innovation of healthy products and materials is to apply reliable emissions testing systems, to perform comparative risk assessments, and further develop voluntary guidelines and standards to assist in the evaluation of products, materials and technology.[35]
There is a big opportunity for architects, designers and manufacturers to more carefully consider the materials they choose, and for building owners to be more selective in the products they approve for purchase.

Healthier products are available, but better mandates and guidance need to be provided to the project managers, project advisors and delivery teams, and the purchasing community so they can specify these healthier products for our buildings.

While a broad group of stakeholders from across the building industry have collaborated to make significant progress in promoting chemical transparency and hazard reduction, this is just the tip of the iceberg. The number of projects that have pursued healthier material goals is very small compared to the number of buildings constructed or renovated annually. Additionally, the number of products with fully disclosed ingredients is small compared to the number of building products on the market, as shown in Table 2[36].

Progress in product transparency in the building industry

Certification/declaration scheme	Product count (as of February 2017)
Health product declaration	2,167
Cradle to cradle certification*	173
Declare label	359
Commercially available building products**	200,000+

* Cradle to cradle numbers include full certifications for building product only. Material Health certifications are not included.

** Designer Pages, November 2016

Key points

Chemicals used in construction materials can be a risk factor for serious health conditions including cancer, many of which remain untested. In the absence of robust evidence proving these chemicals are not harmful, the precautionary principal should be observed.
Many common products in office environments emit VOCs which may have long and short-term health effects, including a reduction in mental acuity and productivity.
Small investments in air quality, such as selecting healthy materials, confer large returns, however better guidance and more transparency around healthier product choices is needed.
Selecting products that are designed and constructed to reduce emissions (VOCs) is considered the most effective and energy efficient way to improve indoor air quality.
The increased importance on low emitting products is being driven by green building certification programmes and building codes.

WELL Certification

With the knowledge that our built environment can make us happier, healthier and more productive, there is a growing demand to create and certify spaces that advance health and wellbeing.

Third-party certification offers building owners the opportunity to validate their commitment to prioritising health, to promote their building, attract tenants, and retain top talent.

Likewise, manufacturers are experiencing a driver from green building certification programs as well as state and local building codes. These programs and codes typically address Indoor Air Quality (IAQ) issues as part of their scope, and usually include requirements governing the use of low-emitting building materials and furniture products. The most notable programs and codes include the following:

- Leadership in Energy and Environmental Design (LEED)
- WELL
- California Green Building Standards Code

Pioneering building certification schemes such as the Leadership in Energy and Environmental Design (LEED) have traditionally focussed on the 'green' performance of a building, though health aspects such as indoor air quality are touched on. Subsequently there has been a need for certification systems whose primary focus is on health and wellbeing. The WELL Building Standard was created to meet this need and compliment the environmentally focused LEED system[37].
The WELL Building Standard is a rating scheme designed as a roadmap for buildings to deliver more thoughtful and intentional spaces. Backed by a body of scientific research, WELL includes strategies to advance health by setting performance standards for design interventions, operational protocols and policies, and a commitment to fostering a culture of health and wellbeing.
The WELL Building Standard includes ten core concepts, as shown in Figure 1.

Each concept includes features with distinct health objectives. Features can either be preconditions or optimisations; preconditions serve as the foundation of a healthy building and are mandatory for certification, optimisations are optional pathways that projects can pursue to meet certification requirements.
WELL operates on a points-based system, with 110 points available in each project scorecard. Each optimisation feature has a corresponding point value that contributes to the overall points. Depending on the number of points achieved, a project can be awarded a WELL (for owner-occupied projects) or WELL Core (for core and shell buildings) Bronze, Silver, Gold, or Platinum certificate.
Autex Acoustics products contribute to the acoustic comfort, indoor air quality, lighting and visual comfort of a building. When specified for buildings that are pursuing WELL certification, Autex Acoustic products can contribute to points in optimisation features. Table 3 shows a list of the concepts and features that Autex Acoustics contribute to, how they contribute to each feature, and the documents that can be presented as evidence for WELL certification.

Concept	Feature	Part	Contribution of autex acoustics products	Evidence
Light	L02 Visual Lighting Design	Part 1: Provide Visual Acuity	Available in a wide range of colours and reflectance values, providing more flexibility when designing a space to achieve the required Unified Glare Rating (UGR) and illuminance.	Light Reflectance Values (LRVs) – as input for modelling report
	L04 Electric Light Glare Control	Part 1: Manage Glare from Electric Lighting		
	L07 Visual Balance	Part 1: Balance Visual Lighting		
Sound	S01 Sound Mapping	Part 2: Provide Acoustic Design Plan	Highly sound absorptive products, reducing reverberation time, supporting concentration, and increasing speech intelligibility. Can meet the minimum NRC requirements of this standard.	Acoustic Test Report
	S04 Reverberation Time	Part 1: Achieve Reverberation Time Thresholds		
	S05 Sound Reducing Surfaces	Part 1: Implement Sound Reducing Surfaces		
Materials	X01 Material Restrictions	Part 1: Restrict Asbestos	No asbestos which is widely known to be hazardous to health.	Health Product Declaration (HPD)
	X05 Enhanced Material Restrictions	Part 2: Select Compliant Architectural and Interior Products	No halogenated flame retardants and orthophthalates which are associated with health concerns.	Health Product Declaration (HPD)
	X06 VOC Restrictions	Part 2: Restrict VOC Emissions from Furniture, Architectural and Interior Products	Low VOC and formaldehyde emissions and will not contribute to poor indoor air quality.	VOC Emissions Report (CDPH Standard Method)
	X07 Materials Transparency	Part 1: Select Products with Disclosed Ingredients	All ingredients are disclosed down to 100 ppm and published on our Declare labels and Health Product Declarations (HPD) to help make fully informed choices when deciding which products to use. Our Declare labels are third-party verified, which gives assurance that the information disclosed is true and accurate.	Declare Label Health Product Declaration (HPD)
		Part 2: Select Products with Enhanced Ingredient Disclosure		
		Part 3: Select Products with Third-Party Verified Ingredients		
	X08 Materials Optimization	Part 1: Select Materials with Enhanced Chemical Restrictions	Declare certified to be Living Building Challenge (LBC) Red List Free, meaning they do not contain harmful chemicals and are safe to use	Declare Label
Mind	M02 Nature and Place	Part 1: Provide Connection to Nature	Available in nature-inspired colours, with the option for customisations to create designs inspired by nature or designs that celebrate culture and identity.	Architectural Drawings (with Autex Acoustics products specified)
		Part 2: Provide Connection to Place		
	M07 Restorative Spaces	Part 1: Provide Restorative Space	Available in calming colours, textures, and forms that promote mental restoration and provide relief from mental fatigue or stress.	

Conclusion

With growing awareness of the benefits of wellness-led design, backed by the latest public health and building design research, the healthy building movement shows no signs of slowing down. We've long been aware of the detrimental effects of certain materials, such as those containing silica or emitting VOCs, yet the ability of interior materials to positively contribute to health and wellbeing outcomes may have been overlooked—particularly in relation to other elements of healthy building design.

Materials can make significant contributions to multiple healthy building fundamentals; to the multisensory dimensions of the indoor environment, favourably regulating the way we are influenced by light and sound, and to the indoor air quality, which significantly effects the performance and wellbeing of occupants.

To achieve acoustic comfort, the specific absorptive properties and positioning of acoustic material in a space can be detailed to meet the unique requirements of the environment. A range of colour options, applications and customisations of interior surfaces can be specified to provide a comfortable visual experience—from biophilic design initiatives for connection to place and nature, to improved illuminance, light uniformity, reduced glare and energy saving through increased reflectance values. Improving indoor air quality is effectively achieved through source control of products that are constructed to reduce the emissions potentially harmful chemicals. With the increasing importance of low emitting products driven by awareness of their effects, manufacturers have a responsibility to be transparent in their reporting of chemical composition and potential hazards. Pursuing healthier materials, however, is still far from industry standard.

With more transparent and healthy products available on the market, architects and designers have the opportunity to be more selective in the materials they choose, which will further incentivise the broader adoption of transparency and health-consciousness in production.

With the growing demand for healthy spaces, the WELL system offers a roadmap to achieve certification, promoting the building owner's commitment to occupants' health and reflecting design leadership in a movement that is here to stay. Major human health gains through upgrading the indoor environment can be achieved if the planning and construction of new builds, as well as remodelling and renovation projects, are based on an integrated design process for achieving health enhancing environments, efficiency in the use of materials, high functionality, comfort, wellness, and productivity. High quality material detailing for acoustic and visual comfort and indoor air quality should be given its due diligence in the design process for its ability to promote health and wellbeing, and the earlier heathy materials are considered within a project timeline the more opportunities there are to explore viable material options. Autex Acoustics is transparent in their products' ingredients lists and verified harmful chemical free status, and their contribution to WELL certification exemplifies the capacity of these materials to improve human health and wellbeing.

References

1 Ürge-Vorsatz, D., Khosla, R., Bernhardt, R., Chan, Y.C., Vérez, D., Hu, S., Cabeza, L.F. (2020). Advances Toward a Net-Zero Global Building Sector. Annual Review of Environment and Resources. 45: 227–269.

2 Allen, J.G., Bernstein, A. (2020). The 9 Foundations of a Healthy Building (PDF). 9Foundations.

3 Rasmussen, M., & Foldbjerg, P., Christoffersen, J., Daniell, J., Bang, U., Galiotto, N., & Eriksen, K. (2017). Healthy Homes Barometer 2017 - Buildings and Their Impact on the Health of Europeans. VELUX. (PDF)

4 Allen, J.G., Bernstein, A. (2020). The 9 Foundations of a Healthy Building (PDF). 9Foundations.

5 Uhde, E., Salthammer, T. (2007) Impact of reaction products from building materials and furnishings on indoor air quality—A review of recent advances in indoor chemistry. Atmospheric Environment 41: 3111-3128.

6 McGroarty, B. 2018 Global Wellness Economy Monitor. Global Wellness Institute. Available at: https://globalwellnessinstitute.org/press-room/statistics-and-facts/

7 World Health Organization. (2006). Constitution of the World Health Organization – Basic Documents, Forty-fifth edition, Supplement. (PDF).

8 Wimalasena, N.N., Chang-Richards, A., I-Kai K.W., Dirks, K.N. (2021) Housing Risk Factors Associated with Respiratory Disease: A Systematic Review. Int. J. Environ. Res. Public Health. 18(6): 2815.

9 Marija, S.T., Jeong, T.K. (2012) Beyond the science and art of the healthy buildings daylighting dynamic control's performance prediction and validation. Energy and Buildings. 46: 159-166.

10 Babisch, W. (2011) Cardiovascular effects of noise. Noise Health. 13:201-4

11 Shelter (2017) The impact of housing problems on mental health. Shelter.org.uk. (PDF).

12 Gregory, A., Cone, E. (2015). When the walls come down. Oxford Economics. (PDF).

13 Buildings and Health. Sustainable Facilities Tool. Available at: https://sftool.gov/learn/about/576/buildings-health#ratingsystems

14 The Drive Toward Healthier Buildings 2016: Tactical Intelligence to Transform Building Design and Construction SmartMarket Report. Dodge Data and Analytics and World Green building council. (PDF).

15 Miedema, H. (2001) Noise and health: How does noise affect us? Proceedings of Inter-noise, The Hague, The Netherlands, 1; 3–20

16 Miedema, H. (2001) Noise and health: How does noise affect us? Proceedings of Inter-noise, The Hague, The Netherlands, 1; 3–20

17 Jafari, M. J., Khosrowabadi, R., Khodakarim, S., & Mohammadian, F. (2019). The Effect of Noise Exposure on Cognitive Performance and Brain Activity Patterns. Open access Macedonian journal of medical sciences, 7(17), 2924–2931.

18 Zagreus, L., Huizenga, C., Arens, E., Lehrer, D. (2004) Listening to the occupants: a Web-based indoor environmental quality survey. Indoor air. 14(8): 65–74

19 Panagiota, A., Papadopoulos, A.M. (2017) Occupants' thermal comfort: State of the art and the prospects of personalized assessment in office buildings. Energy and Buildings. 153: 136-149.

20 Burglund, B. (1999) Guidelines for Community Noise. WHO, Geneva. (PDF).

21 WELL Building Standard. Comfort. Features 74,78,79,80. Available at: https://standard.wellcertified.com/comfort/sound-barriers

22 Giarma, c., Tsikaloudaki, K., Aravantinos, D. (2017) Daylighting and Visual Comfort in Buildings' Environmental Performance Assessment Tools: A Critical Review. Procedia Environmental Sciences. 38: 522-529.

23 Van Bommel, W.J.M., Van den Beld, G.J. (2004) Lighting for work: a review of visual and biological effects. Lighting Research and Technology. 36: 255–266.

24 International WELL building institute. (2021). Light. Retrieved from Standard WELL V2: tps://v2.wellcertified.com/wellv2/en/light/feature/4

25 Terrapin Bright Green, LLC. "14 Patterns of Biophilic Design." 14 Patterns of Biophilic Design. 2014. Available at: www.terrapinbrightgreen.com/reports/14-patterns. Accessed 2021.

26 Kellert, S., and Calabrese, E. The Practice of Biophilic Design - A Simplified Framework. 2015. www.biophilic-design.com.

27 Klepis, N., Nelson, W., Ott, W. et al. (2001) The National Human Activity Pattern Survey (NHAPS): a resource for assessing exposure to environmental pollutants. J Expo Sci Environ Epidemiol 11, 231–252

28 The President's Cancer Panel Report. 2010. NRDC. Safer Chemicals Healthy Families. (PDF). Accessed 2021.

29 The Frank R. Lautenberg Chemical Safety for the 21st Century Act. 2016. EPA Assessing and Managing Chemicals Under TSCA. Available at: https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/frank-r-lautenberg-chemical-safety-21st-century-act. Accessed 2021.

30 Allen J.G., MacNaughton P., Satish U., Santanam S., Vallarino J., Spengler J.D. (2016) Associations of Cognitive Function Scores with Carbon Dioxide, Ventilation, and Volatile Organic Compound Exposures in Office Workers: A Controlled Exposure Study of Green and Conventional Office Environments. Environ Health Perspect. 124(6): 805-12.

31 Allen, J.G., MacNaughton, P., Satish U., Santanam, S., Vallarino, J., Spengler, J.D. (2016). Associations of Cognitive Function Scores with Carbon Dioxide, Ventilation, and Volatile Organic Compound Exposures in Office Workers: A Controlled Exposure Study of Green and Conventional Office Environments. Environmental Health Perspectives. 124(6).

32 MacNaughton, P., Pegues, J., Satish, U., Santanam, S., Spengler, J., Allen, J.G. (2015) Economic, Environmental and Health Implications of Enhanced Ventilation in Office Buildings. Int J Environ Res Public Health. 12(11):14709-22

33 Fisk, W.J., Black, D., Brunner, G. (2011) Benefits and costs of improved IEQ in U.S. offices. Indoor Air. 21(5): 447-67.

34 MacNaughton, P., Pegues, J., Satish, U., Santanam, S., Spengler, J., Allen, J.G. (2015) Economic, Environmental and Health Implications of Enhanced Ventilation in Office Buildings. Int J Environ Res Public Health. 12(11):14709-22

35 Healthy Buildings Healthy People: A Vision for the 21st Century. 2001. EPA (PDF).

36 Yang, F., Tepfer, S. (2018) Prescription for Healthier Building Materials: A Design and Implementation Protocol. ARUP. Available at: https://www.arup.com/perspectives/publications/research/section/prescription-for-healthier-building-materials-a-design-and-implementation-protocol

37 Allen, J., and Macomber, J. Healthy Buildings. e-book, Amsterdam, Netherlands, Amsterdam University Press, 2020.

38 International WELL Building Institute. WELL v2 Certification. The WELL Building Standard. IWBI, 2021, www.wellcertified.com/certification/v2.