

BauBuche Beech laminated veneer lumber

Wood for well-being



Sheet **TABLE OF CONTENTS**

2	15.1	Foreword
3	15.2	Experiencing wood with all our senses
	15.2.1	Wood and acoustics
	15.2.2	Wood and haptics
	15.2.3	Wood and smell
	15.2.4	Wood and visual impact
	15.2.5	Wood and indoor climate
5	15.3	Effects of wood in buildings on human well-being
	15.3.1	Hospitals and care facilities
	15.3.2	Kindergartens and schools
	15.3.3	Office buildings
	15.3.4	Other buildings
	15.3.5	Conclusions
11	15.4	Sources

© Pollmeier Massivholz GmbH & Co.KG

Pferdsdorfer Weg 6
99831 Creuzburg

BauBuche consulting service for
architects, civil engineers, builders and
timber construction companies
P +49 (0) 36926 945 560
baubuche@pollmeier.com

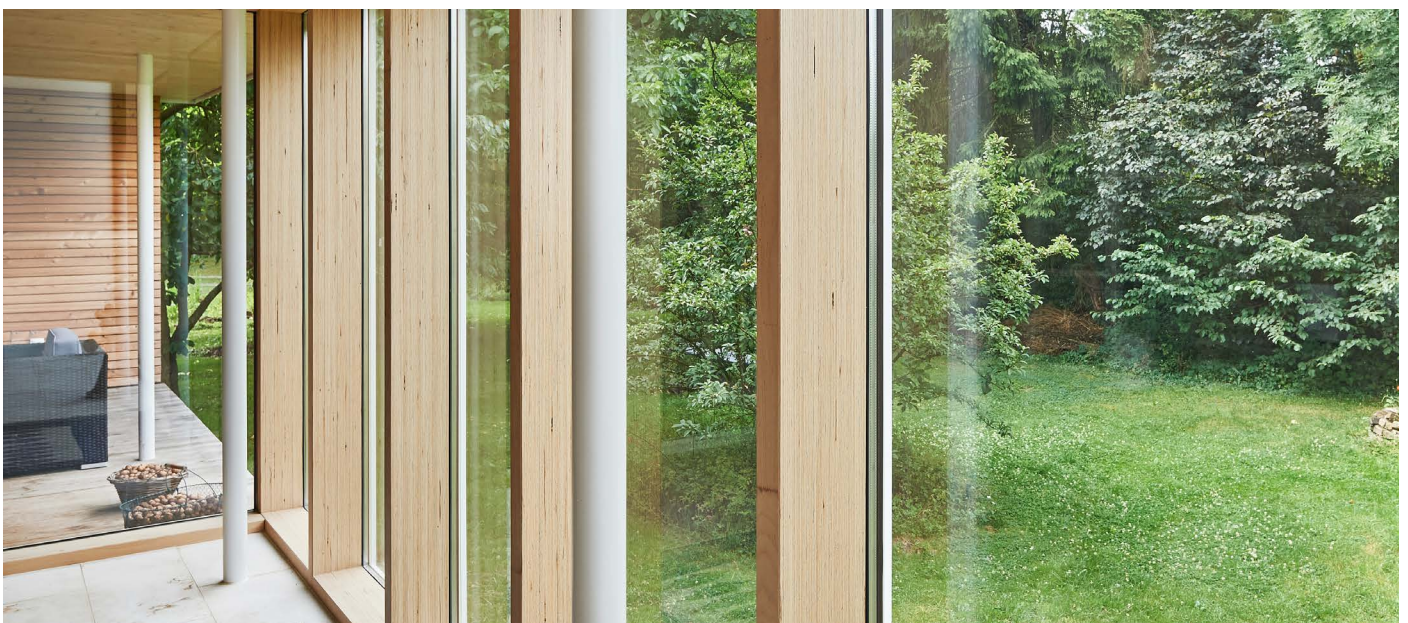
Consulting service on sawn timber,
BauBuche, Pollmeier LVL
and contact for trade:
P +49 (0) 36926 945 163
sales@pollmeier.com

15.1 Foreword

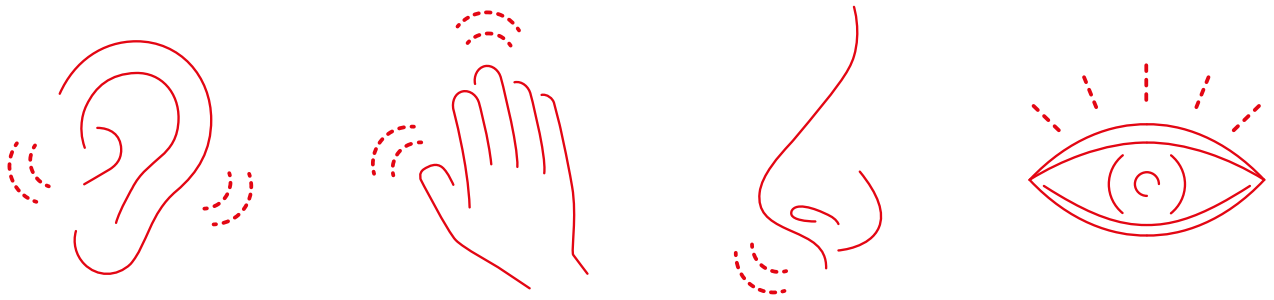
Although more and more people live in urban areas, most of us have still a strong connection to nature – consciously or unconsciously. Studies show that we all long for natural elements that give us comfort and a sense of safety, especially if our lives are rather hectic.¹ It has been shown that even just looking at nature has a positive effect on our body. Our blood pressure drops, and our muscles relax, which makes us feel good.^{2,3,4} Modern people spend most of their time in buildings⁵, be it at work, in school or at home. For our well-being, it is therefore more important than ever that we stay in contact with nature by bringing it into our homes and working environments. By incorporating natural elements into our indoor spaces, for instance with wood or plants, we can experience nature in our urban environments. Biophilic design deals with the use of direct and indirect nature in buildings.⁶

Biophilic design = concept in building industry to increase occupant connectivity to the natural environment through the use of direct nature, indirect nature, and space and place conditions.

“We shape our buildings, and afterwards, our buildings shape us.” This quote by Winston Churchill shows that the thinking behind biophilic design goes back some time. The rooms and spaces in which we move determine how we work, learn and relax. Given the longing for nature and the huge impact the environment has on the well-being and performance of humans, we wanted to find out how wood as a building material affects how people operate and feel. To do this, we must first examine how we experience wood through four of our five senses.



Conservatory built with BauBuche beams Conservatory with full-height glazing and post & beam structure
Architect Dipl.-Ing. Michael Danke, Danke Architekten **Timber construction** Holzbau Stassny, Heinsberg

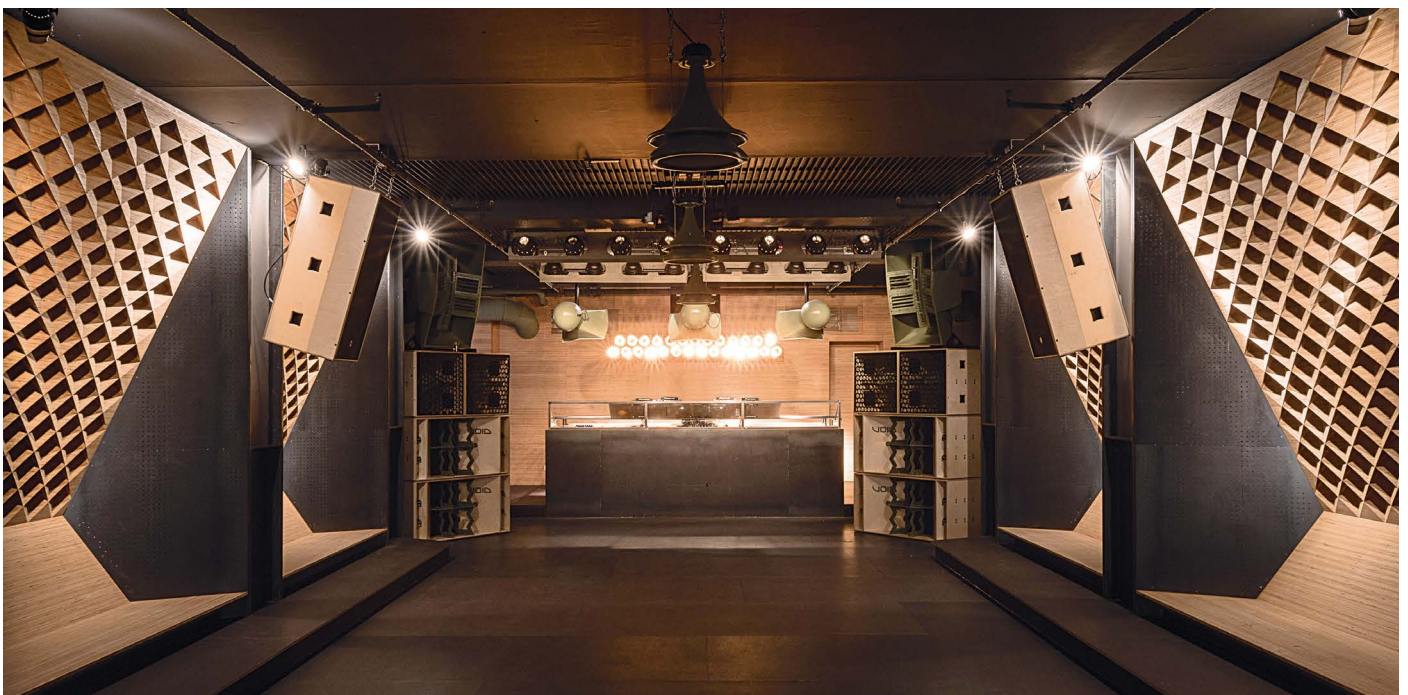


15.2 Experiencing wood with all our senses

15.2.1 Wood and acoustics

The acoustics of a room are determined by the objects and surfaces in it, and their shape and material properties. Smooth, bare surfaces reflect sound, resulting in strong and prolonged reverberation. Structured or curved surfaces diffuse the sound waves.⁷ The demands we have with regard to room acoustics depend on the nature of the space and its use. In open-plan offices or kindergartens, we would like to keep the noise level as low as possible. Concert halls and sound studios on the other hand are optimised for perfect pitch and sound. In rooms with excessive reverberation, communication is made difficult by background noise. Also, such rooms are experienced as cold and unfriendly.⁸ Thanks to its elasticity and surface structure, solid timber in the form of surface-mounted wall panelling is an effective sound absorber in the medium- to low-frequency range.

Solid wood has excellent sound absorption properties in the medium- to low-frequency range.



BLITZ Club Munich Beech interior for a perfect music experience Interior design Simon Vorhammer and Andreas Müller (Studio Knack) Timber construction Gruber Schreinerei GmbH & Co.KG

Unsealed or rough-cut wood can be used for broad-range sound absorption. The natural material gives music and speech extra warmth.⁹

As the general material properties have a much greater effect on sound than the surface finish, room acoustics are often optimised by using special materials other than wood.¹⁰ However, the psychoacoustic impact of rooms clad in timber should not be underestimated. Psychoacoustics is the study of sound perception and audiology. Research shows that the perception of sound is influenced by other stimuli rather than just audible waves.¹¹ This is particularly true for wood, as it evokes a range of experiences through other senses.

15.2.2 Wood and haptics

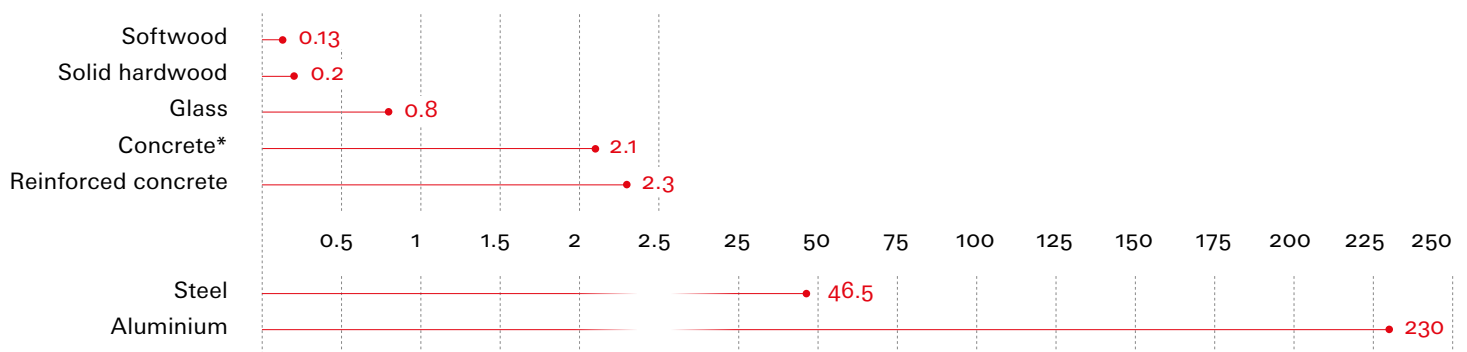
When we touch a piece of wood and a piece of metal that have the same temperature, we always perceive the wood as being warmer. How can this be? The explanation lies in the physics of the objects: Metals are good thermal conductors. This means that they absorb heat from our hands, taking it away from our body. Wood is a much poorer thermal conductor and therefore absorbs heat from the environment at a much slower rate.¹²

When it comes to haptics, wood comes once more top when compared with other popular building materials such as marble and tiles. Studies show that touching wood with the palms of our hands leads to a lower heart rate and reduced brain activity, indicating that we are relaxed.¹³ A similar effect is likely when we walk barefoot on a timber floor. Other studies reveal that wood chairs are generally perceived as more comfortable, warm and soft when compared with chairs made in aluminium or plastic. Of these three materials, wood has the lowest thermal conductivity, while aluminium has the highest. The chart below compares the thermal conductivity of various materials.

The low thermal conductivity of wood makes for a much warmer room ambience than concrete or steel.

Thermal conductivity of building materials in $[W/(m \cdot K)]$

Source: www.therm-ings.de/wärmebrückenwelt



*Specific weight $\rho = 2400 \text{ kg/m}^3$

Apart from the thermal conductivity, our haptic perception of a material is greatly influenced by its surface structure and finish. Rough, porous surfaces are generally perceived as more pleasant to the touch than smooth finishes¹⁴.

15.2.3 Wood and smell

Wood has a distinct smell. Although each species has its own scent, our olfactory system instantly recognises the smell of wood. Considering that humans have for thousands of years relied on wood as a primary resource, for example as a building material, it comes as no surprise that the smell of wood is generally being perceived as pleasant and comforting. This effect has been well studied.¹⁵ Wood does not only smell good, its scent has a calming and relaxing effect on people. Studies show that the smell of wood can even reduce anxiety and stress.¹⁶ The scent of the Swiss pine is for instance known to help people sleep better and to boost their general well-being.¹⁷

The smell of wood has a calming and relaxing effect on humans.

And there is more: Smells activate important areas of the brain, especially those associated with memory.¹⁸ That is why scents do not only help us to relax, but also keep us mentally agile. The use of wood in classrooms or nursing homes can thus have a huge positive effect on pupils or the elderly.

15.2.4 Wood and visual impact

People perceive the colour of wood as warm and pleasant. In colour psychology, the brown colours typical for wood are classified as warm hues, associated with dependability and safety.¹⁹ Wood reflects mainly long-wavelength light that we see as yellow and red hues, which are again perceived as warm colours.²⁰

Wood is a natural regulator of indoor air humidity.

15.2.5 Wood and indoor climate

The indoor climate is something that affects all our senses – hearing, touching, seeing and smelling. This experience can be enhanced simply by incorporating wood elements in the design. Wood is a living material that absorbs and releases moisture. It is thus able to compensate fluctuations in air humidity within an enclosed space. If the air is extremely moist, water vapour is absorbed into the wood. As the air dries, the vapour is gradually released again to the ambient air.²¹



New gym hall, Islisberg The girders span 12.60 m but measure only 90 cm in height and 20 cm in width.
Architects Langenegger Architekten AG, Muri **Structural design** Makiol Wiederkehr AG, Beinwil am See
Timber construction Max Vogelsang AG, Wohlen

15.3 Effects of wood in buildings on human well-being

What do we associate with wood? What distinguishes wood from other building materials?

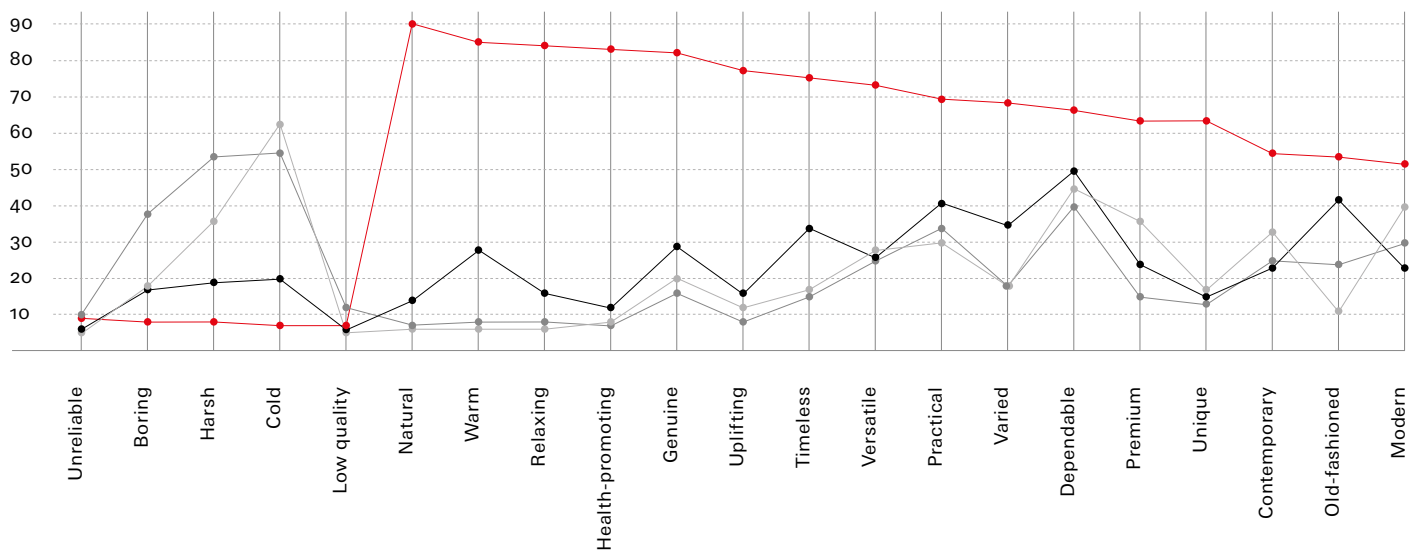
The chart below shows that industrial materials such as brick, concrete and steel are assigned properties that differ greatly from those associated with wood. Wood tops in particular with keywords that have a positive connotation, such as “warm”, “health-promoting”, “practical” and “relaxing”.²²

Comparison of properties associated with materials

Agreement in percentage

Survey of 1000 people over 18 years of age living in Australia

• Wood • Brick • Concrete • Steel



Source: Knox, A., Parry-Husbands, H. & Pollinate (2018)

The properties associated with wood affect people living and working in buildings with timber, as has been shown in various studies concerning public facilities.

15.3.1 Hospitals and care facilities

Buildings where people are treated and cared for should be constructed so as to promote the well-being of patients, occupants and staff. Wood can make a major contribution to a positive environment. Studies show that patients in hospital wards with a timber interior recover better from operations, as pain and stress disappear quicker.²³ The warm look of wood creates a cosy environment far away from the usual white and impersonal hospital atmosphere that tends to make people nervous.

At the Dandenong Mental Health Centre in Australia, wood has been put to excellent use in order to create a healing environment. Both the interior and the exterior of the centre are dominated by wood, and the overall atmosphere is one of natural warmth.²⁴

Wood in hospital buildings can promote healing and recovery.

Similar positive effects were observed in nursing homes. Where the interior was designed in wood, patients behaved differently:

- _ Social interaction increased
- _ Relationships were more harmonious
- _ Purposeful activity increased
- _ Patients showed greater mental alertness

These are all factors that can reduce the risk of dementia and health decline.²⁵

Social interaction of older people is greater where they live in an environment where wood is used as a building material.

Concerns that wood is not suitable for hospital and nursing home environments where hygiene is a key priority are unfounded. Analyses of chopping boards in kitchens showed that the growth rate of harmful germs on plastic boards is significantly higher than on wooden boards.²⁶

Similar findings were made in studies that examined the propagation of germs in hospitals. On wooden surfaces, the examined germs died quicker than on plastic surfaces. It has even been shown that the antimicrobial properties of wood kill off typical hospital germs.²⁷ This effect is most prominent on untreated surfaces, and significantly reduced where the wood is oiled or painted.²⁸

15.3.2 Kindergartens and schools

“Children always experience their environment with all their senses and learn by observing and experimenting. Good architectural design that incorporates natural, untreated materials awakes the curiosity that is typical for children and invites them to explore and use their imagination – which are the elements of proper learning,” says journalist Bettina Rühm. Wood in kindergartens stimulates the senses of our young ones through its look, touch and characteristic smell.²⁹

The heart rate of pupils taught in classrooms with wood is 8600 pulses less per day.

Schools have long known about the benefits of natural materials in classrooms, both for pupils and teachers. In a study carried out in Germany, a group of pupils was taught for ten months in a classroom with a wood interior, while a second group was learning in a room without any wood. The results were startling: In children in the “wood class”, the heart rate dropped by 7 percent on average, which is equal to 8600 pulses less per day. Despite the obvious relaxing effect of the environment on students, there were no signs of lethargy or drowsiness. In addition, the interaction between pupils and students in the “wood class” was much more cooperative than in the reference class. The study also found that there were very few signs of wear and tear of the timber floor and furniture in the classroom. It appears that the children cherished their learning environment and took care of it.³⁰



Comprehensive school Riedberg Kalbach The modular timber building with BauBuche girders won the timber construction award of the State of Hesse. **Proprietor** City School Board, Frankfurt/Main **Planners** NKBAK, Frankfurt/Main **Timber construction** Kaufmann Bausysteme, Reuthe **Support structure design** Merz Kley Partner ZT GmbH

For children and adolescents, the environment in which they play and learn is particularly relevant for their well-being. If this environment causes permanent stress, there is a high probability that they will at some stage in their lives suffer from a stress-related mental illness.³¹

Wood in educational buildings promotes creativity and independent thinking while providing a relaxed learning atmosphere.

15.3.3 Office buildings

Employees are the greatest asset of every company. There are many ways in which employers can protect the health and boost the productivity of their workforce. First of all, people must feel at ease at their workplace, as they spend a lot of time there. This can be promoted by using wood in the furnishing and interior design of office buildings. Surveys show that people prefer such workplaces, as they give them a sense of security, while boosting energy and innovative thinking.³² Wood in offices also works on the sympathetic nervous system, which is mainly responsible for stress responses such as heart rate and blood pressure.³³ Another study shows that people who work in offices where wood accounts for less than 20% of the interior have a generally more negative view of their work situation than those in offices made primarily in wood (> 60%). The table below shows the positive effect of wood at the workplace from the point of view of employees.³⁴

Effect of wood at the workplace

< 20 %	Visible wood elements at the workplace	> 60 %
47 %	Physical workplace satisfaction	81 %
56 %	Satisfaction with working life	81 %
44 %	Optimistic about the future – most of the time	61 %
49 %	Confident – most of the time	68 %
42 %	Stress levels – low	65 %
65 %	Ability to concentrate	83 %

Source: Knox, A., Parry-Husbands, H. & Pollinate (2018)

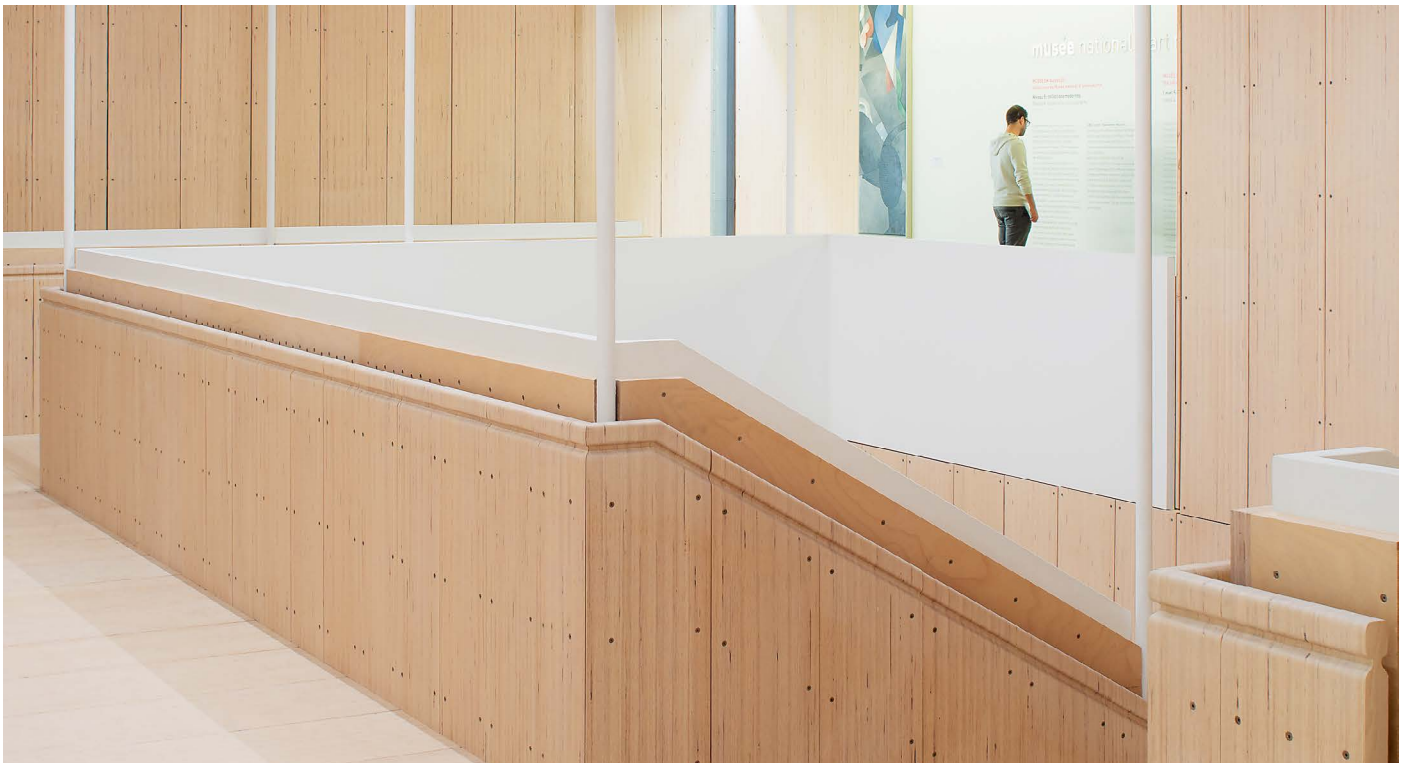
15.3.4 Other buildings

Wood is a great material for virtually any type of room. Some spaces, such as saunas, are obviously traditionally built in wood. There, the physical properties of the material as outlined above come to the fore, as heat is stored and released gradually by the wood. In addition, the air humidity in the sauna is kept at a comfortable level, as water vapour is absorbed into the wood. Also, the wooden sauna benches never become too hot, thanks to the low thermal conductivity of the material.³⁵ These are some of the main reasons why wood is still the preferred material in saunas and other wellness facilities. Wood with its warm touch promotes relaxation, which is very desired in these places.

The use of wood can, however, also be of great benefit in spaces that are much more hectic. In Copenhagen Airport, travellers walk on a timber floor painted in a warm brown hue. Few people know that this floor is already 50 years old and still looks great. The floor helps reduce stress among passengers, and its pattern guides people intuitively.³⁶ In the airport of Madrid, people do not look down to the floor but up. Made from gently curved laminated bamboo laths, the attractive ceiling gives the huge airport hall an air of calm.³⁷

15.3.6 Conclusions

Studies carried out in various fields of research show that the use of wood in buildings and interior design has many benefits for proprietors and occupants, as natural materials immediately generate positive associations with nature. Wood gives us a sense of warmth and comfort, lowers our blood pressure and heart rate, reduces stress and anxiety and promotes social interaction. The positive effects of wood on our health and well-being are no longer disputed. Incidentally, building with wood stores carbon—in the form of CO₂ that trees have absorbed from the atmosphere during their growth—for the entire lifespan of the product. (see EPD-POL-20230326-IBA1-DE) Wood has been with us since the dawn of time and will continue to play a crucial role in our lives.



Centre Pompidou, Paris Eye-catching design combining the warmth of timber with a lightness that fits the landmark building **Architects** Benoît Sindt (studiolada), Nancy; atelierpng, Paris **Installation** Ziliani (Mr. Cordonnier), Charpentiers de Paris (Mr. Richardet), Prodesign (Mr. Senga), Delec (Mr. Cheron), Samex (Mr. Piochot)

15.4 Sources

- 1 Heath, O. (n. y.): **Biophilic Design – connecting with nature to improve health & wellbeing**, [online] <https://www.oliverheath.com/biophilic-design-connecting-nature-improve-health-well/> [27/06/2019].
- 2 Ulrich, R. S., Simons, R. F., Losito, B. D., Fiorito, E., Miles, M. A. & Zelson, M. (1991): **Stress recovery during exposure to natural and urban environments**, in: Journal of Environmental Psychology, vol. 11, no. 3, pages 201-230.
- 3 Parsons, R., Tassinary, L. G., Ulrich, R. S., Hebl, M. R. & Grossman, A. M. (1998): **The view from the road: Implications for stress recovery and immunization**, in: Journal of Environmental Psychology, vol. 18, no. 2, pages 113-140.
- 4 Laumann, K., Garling, T. & Stormark, K. M. (2003): **Selective attention and heart rate responses to natural and urban environments**, in: Journal of Environmental Psychology, vol. 23, no. 2, pages 125-134.
- 5 Anonymous (n. y.): **Für Mensch und Natur ein Segen**, [online] <http://www.proholzbw.de/erstaunliches/wussten-sie-schon/warum-holz-gut-fuer-mensch-und-klima-ist/> [01/07/2019].
- 6 Heath, O. (n. y.): **Biophilic Design – Connecting with Nature to improve health & wellbeing**, [online] <https://www.oliverheath.com/biophilic-design-connecting-nature-improve-health-well/> [27/06/2019].
- 7 Mommertz, E. (2011): **Holzflächen zur Raumakustik – vom Kindergarten zum Konzertsaal**, in: 1. Internationale Schall- und Akustiktag 2011.
- 8 Parasilencio (n. y.): **So leicht lässt sich die Raumakustik verbessern**, [online] <https://www.parasilencio.de/raumklang.html> [27/06/2019].
- 9 Niederstätter, C. (2013): **Kindgerechte Raumakustik**, in: 11. Internationales Branchenforum für Frauen IBF 2013.
- 10 ProHolz (2014): **Holz hören**, in: Zuschnitt, vol. 14, no. 56.
- 11 Fastl, H. (2012): **Hören + Akustik = Psychoakustik**, in: 16. Multidisziplinäres Kolloquium der GEERS-STIFTUNG, vol. 19.
- 12 Anonymous (2018): **Über Eisstäbchen, Weinfässer und Parfumdüfte aus Holz**, [online] <https://www.holzigstgenial.at/blog/ueber-eisstaebchen-weinfaesser-und-parfumduefte-aus-holz/> [28/06/2019].
- 13 Ikei, H., Song, C. & Miyazaki, Y. (2017): **Physiological Effects of Touching Wood**, in: International Journal of Environmental Research and Public Health, vol. 14, no. 7, page 801.
- 14 Kotradyová, V. (2013): **Visuelle und haptische Authentizität der Holzoberfläche**, 11. Internationales Branchenforum für Frauen IBF 2013.
- 15 Suttie, E., BM TRADA (2018): **The role of wood in healthy buildings**, [online] <https://www.trada.co.uk/publications/other-technical-guidance/the-role-of-wood-in-healthy-buildings> [28/06/2019].
- 16 Schreiner, L., Beauchamp, J. & Büttner, A. (2017): **Characterisation of Odorants in Wood and Related Products: Strategies, Methodologies and Achievements**, in: Pro Ligno, vol. 13, no. 4, pages 55-62.
- 17 ProHolz (2010): **Täglich Holz**, in: Zuschnitt, vol. 10, no. 39.
- 18 ProHolz (2013): **Holz im Alter**, in: Zuschnitt, vol. 13, no. 49.
- 19 Anonymous (2016): **Farben und ihre Wirkung**, [online] <https://www.gesundheit.de/wellness/sanfte-medizin/weitere-therapien-und-behandlungen/farben-und-ihre-wirkung> [27/06/2019].
- 20 Masuda, M. (2004): **Why Wood is Excellent for Interior Designing? From Vision Physical Point of View**, [online] http://support.sbcindustry.com/Archive/2004/Jun/Paper_186.pdf?PHPSESSID=ju29gkfhg0oviu50371pv47c9f3 [27/06/2019].
- 21 ProHolz (2006): **Wasserkontakt**, Zuschnitt, vol. 6, no. 22.
- 22 Knox, A., Parry-Husbands, H. & Pollinate (2018): **Workplaces: Wellness + Wood = Productivity**, commissioned by: Forest & Wood Products Australia [online] www.makeitwood.org/documents/doc-1624-pollinate-health-report---february-2018.pdf [27/06/2019].
- 23 Wood2New (2017): **Competitive wood-based interior material and systems for modern wood construction**, [online] www.wood2new.org/wp-content/uploads/2017/02/2017-Wood2New-final-report.pdf [27/06/2019].
- 24 Planet Ark (2015): **Wood housing health humanity report**, [online] <https://makeitwood.org/documents/doc-1253-wood--housing--health--humanity-report-2015-03-00-final.pdf> [27/06/2019].
- 25 Anme, T., Watanabe, T., Tokutake, K., et al. (2012): **Behavior Changes in Older Persons Caused by Using Wood Products in Assisted Living**, in: Public Health Research, vol. 2, no. 4, pages 106-109.
- 26 Ak, N. O., Cliver, D. O. & Kaspar, C. W. (1994): **Cutting Boards of Plastic and Wood Contaminated Experimentally with Bacteria**, in: Journal of Food Protection, vol. 57, no. 1, pages 16-22.
- 27 Schuster, A., Schmidt-Eisenlohr, E., Daschner, F. (2016): **Wie hygienisch und sinnvoll ist Holz in Patientenzimmern?**, in: Eine Metastudie der TU München in Kooperation mit ProHolz Bayern (Hrsg.), Gesundheitliche Interaktion von HOLZ – MENSCH – RAUM, page 15.

- 28 Kotradyová, V., Kaliňáková, B. & Boleš, M. (2016): **Wood for health care and therapeutic facilities – second generation of wood properties related to increasing of well-being and public health.** In: Eine Metastudie der TU München in Kooperation mit ProHolz Bayern (publ.), Gesundheitliche Interaktion von HOLZ – MENSCH – RAUM, page 17.
- 29 Anonymous (2015): **Holz stärkt Psyche und Gesundheit,** [online] <http://www.gemeindezeitung.de/cms/core/index.php/bauen-gz-fachthemen-49/1790-gz-19-2015/3634-2015-10-14-07-24-05> [27/06/2019].
- 30 Moser, M. (2009): **SOS – Schule ohne Stress.** HUMAN RESEARCH Institut für Gesundheitstechnologie und Präventionsforschung, Klagenfurt: Weiz & arte.med.
- 31 Lupien, S. J., McEwen, B. S., Gunnar, M. R. & Heim, C. (2009): **Effects of stress throughout the lifespan on the brain, behaviour and cognition,** in: Nature Reviews Neuroscience, vol. 10, no. 6, pages 434-445.
- 32 Ball, R. D., Killerby, S. K. & Ridoutt, B. G. (2002): **First impressions of organisations and the qualities connoted by wood in interior design,** in: Forest Products Journal, vol. 52, no. 10, pages 30-36.
- 33 Fell, D. (2002): **Consumer visual evaluation of Canadian wood species,** FPInnovations Record.
- 34 Knox, A., Parry-Husbands, H. & Pollinate (2018): **Workplaces: Wellness + Wood = Productivity,** commissioned by: Forest & Wood Products Australia [online] www.makeitwood.org/documents/doc-1624-pollinate-health-report---february-2018.pdf [27/06/2019].
- 35 Anonymous (2019): **Warum muss die Sauna aus Holz sein?**, [online] <https://www.klafs.de/gesundheit/sauna-holz.html> [27/06/2019].
- 36 Vilhelm Lauritzen Architects (2018): **Terminal 3 Expansion Copenhagen Airport,** [online] <https://www.vla.dk/en/project/terminal-3-expansion-copenhagen-airport/> [27/05/2019].
- 37 Anonymous (2010): **Gut gerüstet für die Zukunft.** [online] <https://www.detail.de/artikel/gut-geruestet-fuer-die-zukunft-2801/> [27/05/2019].