

WOOD

HOUSING, HEALTH,
HUMANITY



MAKE IT **WOOD**
Do your world some good

PLANET ARK





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Executive Summary

This report provides a review of studies analysing the health and wellbeing benefits of wooden interiors in homes, businesses, places of learning and places for healing. The results of an independent survey are also presented, identifying the attitudes and opinions of Australians on wood.

Multiple physiological, psychological and environmental benefits were identified for wooden interiors:

- Improvements to a person's emotional state and level of self-expression
- Reduced blood pressure, heart rate and stress levels
- Improved air quality through humidity moderation

- Its use as a long-term store of carbon, helping to fight climate change

Surveyed Australians appeared to be innately drawn towards wood. The results found that wood elicits feelings of warmth, comfort and relaxation and creates a link to nature. Australians however appear to still be confused about wood certification.

This report found that there are significant benefits to the use of wood, but that knowledge of this is low among Australians. Promoting these benefits to the general public, homeowners, designers and architects is therefore of significant importance.



A World Indoors

The health and wellbeing benefits associated with spending time outside in nature are well known and have been studied extensively by the scientific community and reported on by Planet Ark¹.

These known benefits include:

- Increased happiness and self-esteem levels^{2,3}
- Increased cognitive abilities^{4,5}
- Decreased stress response, blood pressure, pulse rates and cholesterol levels^{6,7}

However increasing urbanisation rates mean that people have less access to nature in their daily lives and Australians on average now spend over 90% of their time indoors⁸. This coincides with reports of increasing levels of obesity⁹ and nearly half of Australians experiencing a mental health condition within their lifetime¹⁰. As it is not always possible to increase our time spent outside, particularly in areas like workplaces, schools and hospitals, understanding how to incorporate the physiological and psychological benefits of nature into our indoor environments is an increasingly important area of research.

Studies have demonstrated that simply having a view of nature from a window can have significant positive effects, such as shorter postoperative hospital stays¹¹, induced feelings of relaxation in patients at rehabilitation centres¹² and improved comfort levels of employees in offices¹³. Not surprisingly the presence of indoor plants has also been shown to have benefits, such as improved cognitive functioning in office environments¹⁴, increased tolerance of pain in hospital¹⁵ and lowered blood pressure and heart rate¹⁶.

Evidence-based design (EBD) is an area of study that focuses on incorporating the results of empirical research into the quality of the built environment¹⁷. Originating from the field of environmental psychology, EBD works on the notion that the design of the built environment



Office employees working indoors in the absence of nature.

fundamentally impacts the people within it. Of particular interest are designs of physical features that can lead to stress-reduction, productivity and general wellbeing. Since evidence shows viewing nature in both outdoor and indoor settings has health and wellbeing benefits for people, it is logical to examine whether wood, a natural material, produces similar effects.

About This Report

The aim of this report is to examine current literature and empirical studies assessing the benefits of using wood in an indoor environment. The report will also present and discuss the results of a survey commissioned by Planet Ark and conducted by research consultancy Pollinate in September 2014 on the current opinions and attitudes of Australians towards wood along with their exposure to it at home, work and school. 1003 Australians aged 14-64 years old and nationally representative in terms of age, gender and location were surveyed online.

Acknowledgements

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Make it Wood

Wood comes from trees and is a natural, renewable resource, with no two pieces being the same. Its uniqueness is due to the final appearance of wood being dependent on a number of variables, including species, geographic area where the tree grew, growth conditions, size of the tree at harvest, sawing and other manufacturing processes¹⁸ (figure 1).

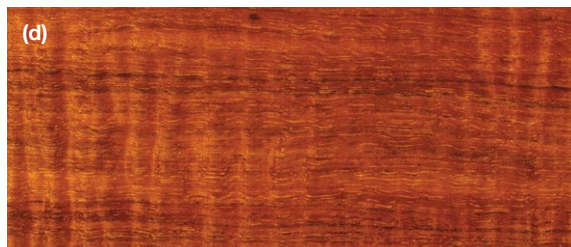



Figure 1. (a) Murray River Cypress-pine (b) Bunya pine (c) Alpine ash (d) Australian blackwood



Horyuji Temple, Japan.

 **Although wood has ancient roots it is experiencing a revival in use.**

Wood is one of the oldest materials used by humans, including its use as a building material. Wooden furniture and funereal items have been found in the pyramids of Egypt and some structures built centuries ago are still standing today. These include the Horyuji temple in Japan built in 700 CE, Greensted Church in England built in 1053 CE and Westminster Hall in London built in 1399 CE.

Although wood has ancient roots and has been used in every culture in the world from before the Stone Age it is experiencing a revival in use. In part this is because of the newly discovered health and wellbeing benefits of exposure to wood, which produce similar effects to those created by spending time in nature.



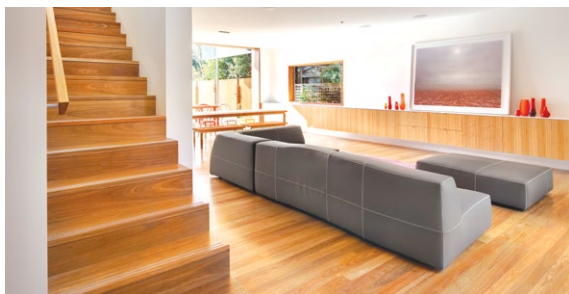
The Benefits of Wood

On the Body

- A Japanese study compared the initial physiological response of 14 people sitting in rooms with either wooden or steel wall panelling. The pulse and heart rate of each subject was measured every second for 20 seconds whilst facing the panelled wall covered by a curtain, followed by 90 seconds with the curtain removed and the wooden or steel panel visible. The study found that exposure to wooden panels significantly decreased the blood pressure of subjects, whilst exposure to steel panels significantly increased it.¹⁹
- An Austrian study examined the heart rates of 30 people who slept in a Stone Pine bed for 3 weeks and compared it to their heart rates when sleeping in a wood imitation bed for 3 weeks. Sleeping in a stone pine bed reduced heart rates by 3500 beats per day compared to when subjects were sleeping in a wood imitation bed.²⁰
- A yearlong Austrian study examined 36 high school students aged 13-15 years old who were taught in either a classroom furnished with floors, ceilings, cupboards and wall panels made of solid wood, or a classroom equipped with a linoleum floor, plasterboard walls and chipboard cupboards. The results showed significant differences between the two groups, with students taught in the wooden classrooms



Exposure to wooden panels significantly decreased blood pressure.



A home incorporating wooden structures and furnishings



Children at the Queensland Art Gallery.



Students taught in the wooden classrooms have decreased heart rates and decreased perception of stress.

having decreased heart rates and decreased perception of stress from interactions with teachers. In contrast, students taught in the control classroom had increased heart rates and had greater stress responses²¹.

The studies examining the effects of wooden rooms and furnishings clearly demonstrate that the presence of wood has positive physiological effects, lowering blood pressure, heart rate and stress responses when compared to other material types. These physiological responses are specifically controlled by the sympathetic nervous system (SNS). SNS activation occurs when the body prepares itself for stress, increasing blood pressure and heart rate, whilst inhibiting digestion, recovery and the immune system in order to deal with any immediate threats it perceives. Long term exposure to environments that induce stress can trigger serious health consequences, including obesity, type 2 diabetes and related cardiometabolic complications²².


Studies also suggest that exposure to stress and stress hormones during childhood and



adolescence increases the probability of individuals developing stress-related mental disorders later in life²³, as well as influencing the timing of puberty²⁴. Decreasing the stress of school (one of the most stressful activities in childhood²⁵) by incorporating natural wood into the classroom can therefore have significant and long lasting positive effects.

On the Brain

- The behaviours and health status of 44 elderly Japanese residents using wooden tables, chairs and tableware at a care home were examined and compared to residents using plastic products. The results indicated that the use of wooden products increased the number of interactions between individuals (i.e. more talkative and more willing to engage with one another), improved emotional state and expanded self-expression in a positive way.²⁶
- A Canadian study has demonstrated that the colours and texture of wood elicit feelings of 'warmth', 'comfort' and 'relaxation' in people²⁷, all emotions that have been shown to reduce stress, anxiety and recovery times in hospital by studies examining the influences of music^{28,29}, plants³⁰ and therapeutic massage³¹.
- A study in New Zealand presented 69 adults with images of 10 modern corporate interiors, chosen


 **The use of wooden products (in a nursing home) increased the number of interactions between individuals.**



The use of wooden products increases social interactions among elderly people.



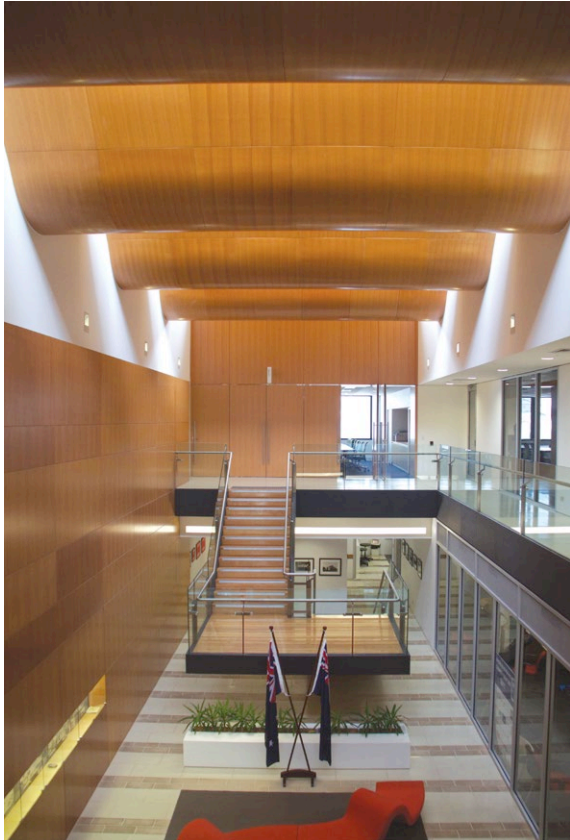
Library at the Dock, Melbourne.

 **Offices with wooden interiors conveyed feelings of innovation, energy and comfort.**

from recently published books showcasing contemporary design. Five of the interiors featured wood significantly, whilst the other five featured no wood at all. Participants were asked to 'identify the organisation you would most like to work for and least like to work for', followed by selecting three adjectives from a list of 24 to indicate their first impressions of each organisation. The presence of wood products within a corporate environment drastically influenced first impressions, with study subjects significantly more likely to want to work for organisations that featured wooden furnishings. Offices with wooden interiors also conveyed feelings of innovation, energy and comfort, whilst offices without wood conveyed feelings of being impersonal and uncomfortable.³²

The positive psychological outcomes of people interacting with wooden products could have significant economic impacts. This is because studies have shown that social interactions that lead to opportunities for self-expression in old people reduces the risk of dementia, a disease that currently costs Australia over \$5 billion every year and affects 44 million people worldwide³³. Shortening hospital stays through reduced recovery times will also reduce costs to the medical system, whilst improved first impressions of organisations will attract business to the Australian market.





Bayside Police station, Melbourne.

 Wood products within a room improve indoor air quality by moderating humidity.

On the Air

- Wood products within a room have been shown to improve indoor air quality by moderating humidity. This effect occurs due to wood absorbing and releasing moisture in order to maintain equilibrium with the surrounding air, known as the equilibrium moisture content. Wood therefore absorbs moisture from the air in humid conditions and releases moisture in dry conditions. ^{34,35}

The ability of wood to moderate humidity is a particularly important effect in workplaces. This is because productivity has been demonstrated to be reduced by an average of 12% in offices where staff are dissatisfied with the quality of the air³⁶.

Visual Appeal, Natural Look

Australians appear to be innately drawn towards wood. When Planet Ark presented survey participants with images of two rooms, one furnished with a wooden chair, desk, blinds and other items made from wood, while the other showed the same items made from plastic, (Figure 2), two out of every three people said they preferred the wooden room. This result occurred despite one in two people saying they were completely unaware that wood had associated health benefits. The images were taken from a study by David Fell (2010), which showed Canadians have similar innate attitudes towards wood³⁷.



Figure 2. Images used in the Planet Ark survey of wooden and plastic furnished rooms. Sourced from David Fell (2010)³⁷



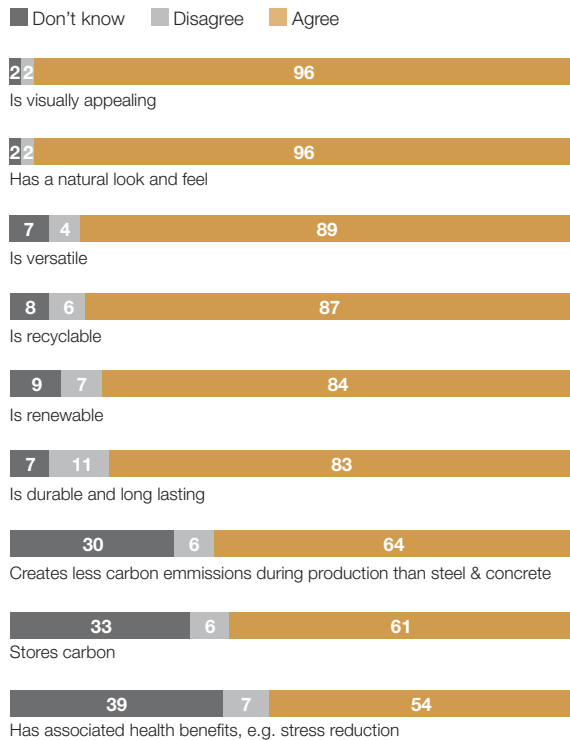
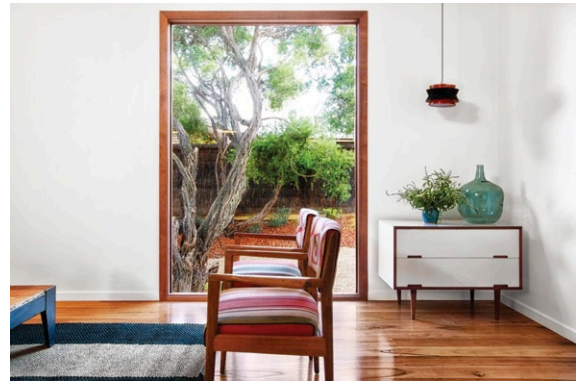


Table 1. Results of the Planet Ark survey on whether Australians ‘agree’, ‘disagree’ or ‘don’t know’ when asked questions about wood.

Table 1 highlights the positive associations that wood induces in people, where an overwhelming 96% of Australians agreed that wood is ‘visually appealing’ and ‘has a natural look and feel’. Eight out of ten people also thought that wood is versatile, recyclable, renewable and long lasting.

Australians however appear to be less aware of the environmental benefits of wood, with only six out of ten survey participants understanding that wood stores carbon and creates less carbon emissions during production than steel and concrete.

The positive views of wood continue even when compared to other material types (Table 2). Wood was viewed as the material that creates a natural look and feel, warm and cosy environments, is visually appealing and is nice to touch by nine out of ten people, and as being the most environmentally friendly by seven out of ten people. By comparison the second most popular material, brick, received an average of 34% less positive feedback. Plastic was seen as the



Interior wood being used to frame views of nature.

An overwhelming 96% of Australians agreed that wood is ‘visually appealing’ and ‘has a natural look and feel’.

cheapest material but it also scored lowest in four out of five categories related to creating pleasant surroundings and being environmentally friendly.

These survey results provide support to the empirical evidence discussed above. Even though many people don’t understand the health and wellbeing benefits of wood they instinctively react to the feelings of warmth and comfort it creates and its natural look and feel. An increasing body of research is beginning to show that being surrounded by wood at home, work or school has positive effects on the body, the brain and the environment.

Material	Perception					
	Creates at natural look & feel	Creates a warm & cosy environment	Visually appealing	Feels nice to touch	Environmentally friendly	Relatively cheap
Wood	93	92	88	87	68	31
Brick	61	62	58	30	47	30
Concrete	25	23	24	20	27	35
Steel	20	16	36	36	28	20
Aluminium	17	15	33	34	30	36
Plastic	14	18	24	36	14	71

Table 2. Results of the Planet Ark survey asking how participants perceive different material types.

Wood in Action

An increasing number of architects who design buildings for healing, learning and relaxation are incorporating significant amounts of wood into their structures to capitalise on its health and wellbeing benefits. Below are a number of examples of the types of work being done in wood along with the ideas of those involved.

Dandenong Mental Health Centre

The Dandenong Mental Health Centre, designed by Bates Smart and the Irwin Allsop Group, is the largest mental health facility in Victoria (Figure 3). Natural timber is used extensively in the walls and ceilings throughout the building, both inside and out, to create a residential and suburban feeling. This is in direct contrast to many mental health facilities that have an unnatural and institutional feel. The use of courtyards, both large and small, with wooden panels creates spaces that also allow light and cross ventilation into the building.

Reclaimed ironbark has been used for the beams and columns in the indoor-outdoor space and the promenade decking is made from local hardwood, recycled from an old wharf structure at Victoria Harbour.³⁸

The building won the 2014 Australian Timber Design Awards due to the combination of modern timber technology, traditional timber use and its specific design for the health benefits of wood.

The judges specifically stated that: ‘The attention to detail is exceptional, clearly demonstrating an understanding of timber design’ and that: ‘The design team demonstrated an understanding of the health benefits of wood’³⁹.

Bates Smart and the Irwin Allsop Group said that they specifically chose wood, both new and recycled, to provide warmth, texture, patterning, tactility and a non-institutional feel to the facility. In addition they stated that wood is durable, low maintenance and has already begun to age gracefully.³⁹



The promenade decking is made from local hardwood, recycled from an old wharf.



Figure 3. Dandenong Mental Health Centre.



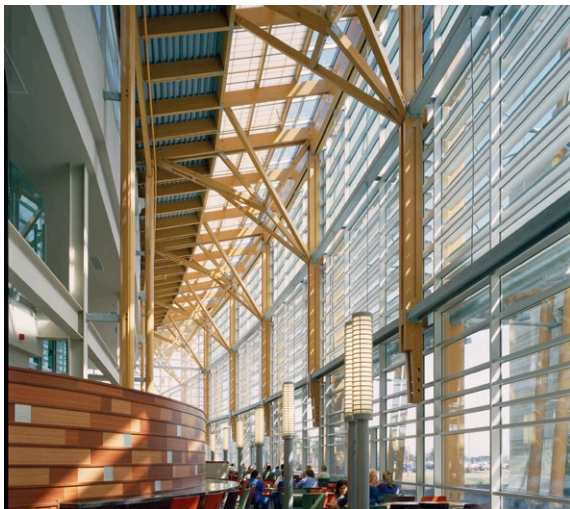


Figure 4. Thunder Bay Regional Health Sciences Centre.

Thunder Bay Regional Health Sciences Centre

The Thunder Bay Regional Health Sciences Centre in Ontario Canada, designed by the Farrow Partnership, is ranked 6th on the list of the world's 30 most architecturally impressive hospitals⁴⁰(Figure 4). The facility includes acute care services, forensic mental health, a maternity ward and a regional cancer centre.

Wood is used as the main structural element for all public areas. The 18,600m² main public corridor is built entirely with heavy timber frames and curves to follow the path of the sun to provide natural light throughout the day. The Centre was also

the first cancer facility in Canada to incorporate direct natural light, skylights and wood panel interior finishes in the radiation treatment rooms to enhance the therapeutic experience for patients.⁴¹

[The] Farrow Partnership stated that when designing the facility they embraced humanism, with the complex design's dramatic use of wood and multiple-height interior spaces flooded with natural light, creating dynamic, innovative and functional places for healing with a non-institutional character⁴². Tye Farrow also specifically quoted that: 'The scientific evidence is extraordinary that the built environment has a significant impact on people's ability to heal as well as on hospital staff effectiveness'⁴⁰.



Candlebark School Library

The library at Candlebark School in the Macedon Ranges in Victoria is an earth-covered timber building constructed into the side of a hill, designed by architect Paul Haar to be a site of learning, reflection and refuge. The aim was to create a visually dramatic and gently warped roof structure that fans out like a book opening to the view below⁴³ (Figure 5).

The facility was designed to promote the use of both new and recycled timber. The ceilings are lined with hoop pine plywood, while the windows and external doors are made from recycled blackbutt timber and the pergola, internal door frames and benches are salvaged Monterey cypress.

The shelves in the library are made from timber and steel racking components, created by a local cabinetmaker using Hoop Pine plywood. This set up was found to be more robust and serviceable than the all-steel alternative commonly found in school and public libraries as well as being less expensive and more attractive.⁴⁴



Internal temperatures during a bushfire would only peak at 29°C

The site also doubles as the school's bushfire shelter. The combination of the earth covered roof, double glazed windows and the massive timber beams gives the building excellent thermal performance, with models showing that internal temperatures during a bushfire would only peak at 29°C⁴⁵. The design of the library highlights how wood can be used in bushfire-prone areas, one of the greatest misconceptions people have regarding the use of wood⁴⁶.

The Candlebark library won the 2012 Australian Timber Design Award. Judges stated that they were greatly impressed by the expert use of engineered timber, its careful detailing and timber selection, and the use of recycled and salvaged timbers to create a natural reading environment.⁴⁷



Figure 5 Candlebark School Library.

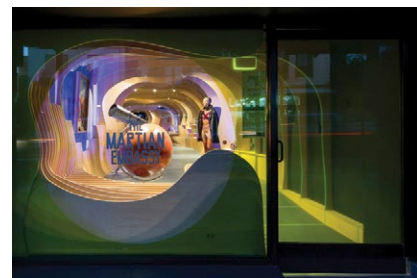


Figure 6 The Martian Embassy.

Martian Embassy

The Martian Embassy in Redfern Sydney is a creative writing centre for young people (Figure 6). The Centre is designed to be a fusion between a whale, a rocket and a time tunnel, created by oscillating plywood ribs, red planet light and sound projections in order to provoke fun and unleash creativity.

Construction was simplified by the flexibility of plywood. Flat sheets were cut into 1068 ribs, which were then put together like a giant puzzle to create a three-dimensional space. The acoustic

qualities of timber further enhanced the sounds, smell and lights of the red planet that animated the space.⁴⁸

Project partners Will O'Rourke and The Glue Society stated that the warm tones of wood transformed the previously long, dark and unloved shop into a source of inspiration that kids are excited to walk into⁴⁸.

The Martian Embassy was a runner up in the Interior Fitout category of the Australian Timber Design Awards.



Fire Safety

A common concern raised in regard to the use of wood as a building material is whether or not there is an increased risk of fire.

Engineers and fire researchers today have a significant body of knowledge of how timber constructions perform in fire. The structural stability of timber is well understood and importantly it is predictable, allowing timber constructions to be created that meet the same fire safety codes as steel and concrete buildings.^{49,50}

Heavy timber constructions have an inherent level of fire resistance. This resistance increases with the thickness of the wooden elements because when timber is exposed to fire the outer layer burns and turns to char. Charring creates a protective layer that acts as insulation and delays the onset of heating for the cold layer below. With continued exposure to fire the char layer grows, increasing the insulation and slowing down the burning rate, providing greater time for escape or intervention.⁴⁹

An additional benefit to heavy timber is the ease of repair after a fire. The charred sections can visually be assessed and evaluated for residual capacity, and the damaged timber can then be cut away and replaced.⁴⁹ This is in contrast to steel, which buckles under extreme heat.

In light timber frame constructions the walls and floors are typically encased in non-combustible gypsum plasterboard to provide protection from fire. This provides the same level of fire resistance as a completely non-combustible material.⁵¹

Just because steel is a non-combustible material does not mean it is unaffected by fire. The thermal conductivity of steel is significantly greater than wood (200-1000 times more). This creates a thermal bridging effect, allowing heat



Deformed steel beams after a fire.

from a fire in one part of a building to spread rapidly to other parts. Fire can also raise the temperature of steel enough to compromise its strength, with a reduction in its load carrying capacity by one third when heated above 540°C causing beams to buckle and floors to collapse.⁵²

A study that examined the rate of injury from hotel, motel and aged care home fires in America and Canada from 1980 to 1998⁵³ found that the presence of sprinklers had a greater impact than the combustibility of the building material (Figure 7)⁵³. In fact sprinkler systems have been shown to be one of the primary factors in limiting fatalities and fire damage in structures of all types.^{52,54}

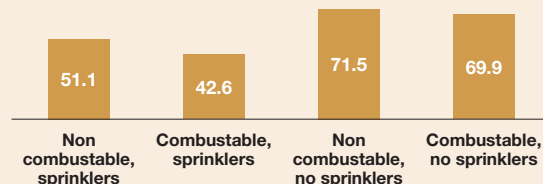


Figure 7. Injury rates (per 1,000 fires) by sprinkler protection status and building material combustibility⁵³.



Be Certain It's Certified

Certification ensures that the wood comes from legally harvested and well-managed forests and plantations. Certified forests are managed with environmental, social and economic factors as a priority, and ensure that when a tree is harvested another one is planted in its place. Without certification it can be difficult or impossible to know whether wood was taken illegally or from high conservation value forests.⁵⁵

Despite its importance there is a high level of confusion regarding certified wood. The results of the Planet Ark survey found that only one out of three people (35%) thought that it was relatively easy to find certified wood, and that only one out of five people (18%) said they trusted the current forest and wood certification systems. This highlights the need to convey to the Australian public how certification works and what to look for when buying wood.

There are three main certification systems in Australia, the Forest Stewardship Council (FSC), the Australian Forestry Standard (AFS) and



Figure 8. FSC, AFS and PEFC logos displayed on products made from timber and paper products derived from certified forests.

the Programme for the Endorsement of Forest Certification (PEFC). These systems set principles and criteria for the management of forests and timber, and certification is only granted after an assessment by an independent third party. These schemes all set different standards on forest certification and chain of custody certification. All timber and paper products derived from forests that have been certified are permitted to carry the registered trademark of that specific scheme (Figure 8).



Products displaying tags to indicate they are made from FSC certified timber.



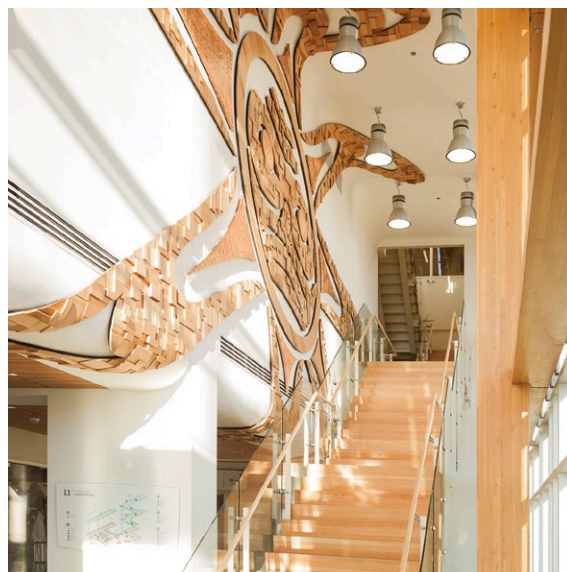
Do Your World Some Good

In addition to its associated health benefits, the use of responsibly sourced certified wood can have significant positive environmental outcomes and help reduce climate change.

The temperature of the earth is dependent on the balance between the amount of energy entering the planet's system from the sun, and the amount reflected and released back into space. The natural greenhouse gas effect is where gases in the atmosphere absorb and retain heat, a natural process that is vital for life on earth. However if these greenhouse gases increase in quantity, more energy is absorbed and the earth heats up.

Current atmospheric concentrations of carbon dioxide, the most important anthropogenic greenhouse gas, are 40% higher than pre-industrial levels⁵⁶. If the current trend in energy usage continues carbon dioxide emissions are estimated to increase by a further 20% by 2035⁵⁶. The Intergovernmental Panel on Climate Change (IPCC) and other authorities have warned that emissions need to be significantly reduced by 2020 in order to avoid the most dangerous impacts of climate change, with the global economy reaching net zero emissions by 2050 to limit global warming to no more than 2°C above pre-industrial temperatures⁵⁷. In order for this to occur emissions not only need to be reduced, but the number of carbon sinks (which remove carbon from the atmosphere) also needs to be increased.

Through the process of photosynthesis trees remove carbon from the atmosphere and store it as biomass, mostly wood. Planting more trees will therefore absorb more carbon and help reduce the impact of emissions. When responsibly sourced wood is used as a building material or to create long-lasting products those items become a carbon store – they lock carbon out of the atmosphere.



Saint Mary's Hospital in Canada, a carbon neutral hospital.



Wooden products and buildings lock carbon out of the atmosphere.

Using wood as a building material also means that the use of much more carbon intensive and non-renewable materials like concrete and steel can be reduced. One study for example identified that the total energy consumption in the manufacturing of steel beams is 2-3 times higher, and the use of fossil fuels 6-12 times higher, than manufacturing timber beams⁵⁸. In New Zealand it has been estimated that a 17% increase in wood usage in the building industry would result in a 20% reduction in carbon emissions from the manufacture of all building materials, 1.5% of New Zealand's total emissions⁵⁹.

Furthermore innovative timber systems designed for prefabrication and disassembly allow for reuse of the timber, creating a more resource-efficient product life cycle than typical demolition and down-cycling, helping to avoid landfill waste⁴⁹.

With the global population growing, increasing rates of urbanisation and the construction of new buildings are inevitable. If these new buildings were built with wood they would not only act as a long-term carbon store, but they would generate fewer emissions in their construction^{59,60}.



Conclusion

The use of wood in the interior of a building has clear physiological and psychological benefits that mimic the effect of spending time outside in nature. The feelings of natural warmth and comfort that wood elicits in people have the effect of lowering blood pressure and heart rates, reducing stress and anxiety, increasing positive social interactions and improving corporate image.

These benefits are particularly important for environments where it is difficult to incorporate

nature indoors, such as hospitals where strict health and safety guidelines may prevent the presence of plants, and office environments where views from the window are of roads and neighbouring concrete buildings.

Responsibly sourced (and certified) timber has clear health and happiness benefits, as well as being a weapon in the struggle against climate change by both storing carbon and eliminating emissions.

Wood is one of the oldest and most versatile building materials used by humanity but it also has a large part to play in the future of health and housing.



Credit Valley Hospital's indoor forest.



Children playing on wooden deck of house.

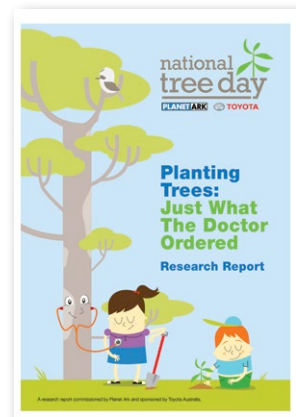
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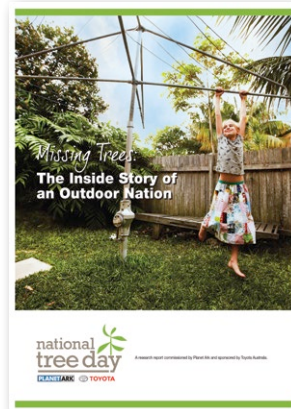


Previous Planet Ark Research

Planet Ark's 2012 report, *Planting Trees: Just What The Doctor Ordered*, explored the intellectual, psychological, physical and mental health benefits of contact with nature for children. It combined a review of current local and international academic research in this field, as well as the results of an independent attitudinal survey that provides an insight into how Australians perceive the link between nature and children's health, wellbeing and development.



Planet Ark's 2013 report, *Missing Trees: The Inside Story of an Outdoor Nation*, focused on outdoor recreation and contact with nature, among adults as well as children. The report outlined the results of an independent survey that explored Australians' attitudes, opinions and behaviour in regard to: the backyard and its decline in Australia; whether the great outdoors is still a key part of how we view ourselves as Australians; and whether there is a link between backyards and the amount of time people spend doing outdoor recreational activities. The report also includes references to a number of relevant external studies.



Planet Ark's 2014 report, *Valuing Trees: What is nature worth?*, took a broader focus and looked at the economic, environmental, health and social benefits of nature in the workplace, at home, in neighbourhoods and in schools. The report examined how much Australians value nature and outlined the results of an independent survey that explored the financial figures people are willing to allocate to these benefits.

