ENVIRONMENT DESIGN GUIDE

TIMBER AND WOOD PRODUCTS – APPLICATIONS AND ESD DECISION MAKING

Andrew Walker-Morison

Wood products are a staple of the construction sector, and are important in delivering environmentally preferable projects. However the sustainability of many wood products remains difficult to assess. This note overviews key issues and considers decision-making issues on a range of common applications, identifying key criteria.

SUMMARY OF

ACTIONS TOWARDS SUSTAINABLE OUTCOMES

Environmental Issues/Principal Impacts

- Forest management practices, particularly with regard to protection of biodiversity, remains the most significant wood products sustainability issue. Plantation management is coming under increasing scrutiny, as are related silvicultural issues such as the use of genetically modified tree crops.
- The use of wood products has the potential to lock carbon and save energy consumption relative to many other materials, however many wood products today are composites or use synthetic chemicals in their manufacture or fixing which have their own environmental loads, for example preservatives toxicity in disposal.
- The sustainability of forest management in many areas of Australia and overseas continues to be subject to vigorous scientific and community debate. In Australia the 2001 State of the Environment Report found that many biologically significant ecosystems had not been protected under the Regional Forest Agreements and that the efficacy of forest management prescriptions remained to be determined. Major conservation groups remain concerned that Australia's conservation reserve system is not adequate and that forests are being significantly degraded through logging practices. Government and industry consider the Regional Forest Agreement (RFA) process to have delivered a comprehensive reserve system and resource security to the industry.
- A principle emerging issue for specifiers is the development of third party certification schemes including the Forest Stewardship Council and Australian Forestry Standard, which seek to provide greater confidence in claims of sustainability. Both offer Chain of Custody Certification, providing commercially for the first time a paper trail for timber from the point of extraction to point of sale.
- A principal barrier to the future reuse or recycling of wood products, an essential characteristic of any sustainable material, is the use of adhesives and other non-mechanical fixing techniques often preventing reuse or recycling.

Basic Strategies

In many design situations, boundaries and constraints limit the application of cutting EDGe actions. In these circumstances, designers should at least consider the following:

- As biodiversity is a priority global issue, use timbers known to come *from* areas with a high level of eco-assurance, timbers known *not* to come from areas of high conservation value, or use *non*-timber products.
- Use local timbers in preference to imported timbers, except where imported timbers have superior environmental attributes.
- Specify smaller section timbers and sizes to optimise for plantation and regrowth timbers.
- Use feature grade rather than 'clear' or 'select' grade timbers.
- Do not over-design. Use high value timbers and veneers in long-lasting applications where they will be appreciated.
- Start with the end in mind: design to allow for reuse and recycling. Use mechanical fixing where possible.
- Minimise toxicity. Not all glues and preservatives are created equal. Use lowest impact option for the application.

Cutting EDGe Strategies

- Use reused and recycled timbers where possible
- Preference third-party certified products with chain of custody, whether local or imported.
- 'Certification' or other market claims without Chain of Custody offer limited scope for independent auditing and should be treated with caution.
- Specify what you want rather than what you don't want.

Synergies and References

- Refer to 'Links and Resources'
- *BDP Environment Design Guide*: PRO 9, PRO 11, PRO 15, PRO 21, PRO 23, DES 31 and CAS 17.

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1.0 OVERVIEW

Australia consumed 4.5 million cubic metres of sawn timber and 1.5 million cubic metres of wood based panels in 2001-2002. In the same year domestic production generated 5.3 million cubic metres of structural wood, consisting of 1.2 million cubic metres of sawn hardwood, 2.3 million cubic metres of sawn softwood and 1.8 million cubic metres of wood-based panels. About 15 per cent of sawn timber consumed in Australia annually is imported, the majority of which is US Oregon and Cedar from USA or Canada (Australian Bureau of Statistics, 2002). Smaller but significant volumes of sawn timber and wood panels are imported from the Philippines, Indonesia and Malaysia. Between 60 and 70 per cent of Australian sawn timber is used in new housing construction. Much of the remaining production is used for home renovation (Clark, 1995).

1.1 Still an important environmental issue

Timber and wood products are potentially among the most sustainable products designers can specify[1]. They can also be among the most environmentally destructive. The challenge to those designing with and specifying timber and wood products is to determine whether products fall into the former or latter category. Many imported wood products come with environmental claims that are difficult to verify, and there remains a diversity of opinion over the ecological and social sustainability of management practices in Australia and overseas. Forests and plantations remain a touchstone for a broad range of industrial, social and political interests.

Commodity	1999-2000 (million m³)
Sawn timber – Coniferous (largely plantation)	2.59
Sawn timber – Broadleaved (largely native forest)	1.3
Hardwood woodchips	6.1
Railway sleepers	0.04
Plywood	0.19
Unlaminated particle board	0.9
Medium density fibreboard	0.6

Table 1. Domestic wood products production
source: (Australian Bureau of Statistics, 2002)

An assessment of the environmental characteristics of timber and wood products from a specifier's perspective must consider:

- The procurement of the raw material including forest management practices
- The amount of energy used to extract and process timber into finished building components
- The impacts of timber throughout its use-phase including impacts on energy efficiency and air quality
- The fate of the product, its recyclability, reusability and biodegradability
- The social sustainability of the supply chain and actions within it.

2.0 ESTABLISHING PRIORITIES FOR DECISION MAKING

Compiled by experts in global ecosystem wellbeing, Table 2 priorities give a useful guide to global-local decision-making, although they must be compared with particular local imperatives and project-specific issues.

Relatively high-risk problems	Relatively medium-risk problems	Relatively low-risk problems
• Habitat alteration and destruction • Species extinction and overall loss of biodiversity • Stratospheric ozone depletion • Global climate change	• Herbicides/pesticides • Toxics, nutrients, biochemical oxygen demand, and turbidity in surface waters • Acid deposition • Airborne toxics	• Oil spills • Groundwater pollution • Radionuclides • Acid runoff to surface waters • Thermal pollution

Table 2. Global environmental priorities
(US EPA 1990) The order of the environmental issues within each heading is not meant to imply a ranking.

[1] In this note timber is defined as any material that includes predominantly solid wood-sawn products (softwood and hardwood), glue laminated material, plywood, Laminated Veneer Lumber, Oriented Strand Board, and so forth. Wood products are defined as any other material that is made of wood fibre e.g. particle boards (hardboard, chipboard, MDF) paper, cardboard, fibre insulation, and so forth.

3.0 DECISION-MAKING FLOW-CHART (DFC)

Utilising these global environmental priorities and integrating human health priorities, the DFC aims to give guidance to ESD decision-making. It is arranged in a process decision-tree, that is, it is suggested that issues be considered in this order, balancing a combination of environmental priorities (in descending order broadly), building in design flexibility, and the realities of the design decision-making process.

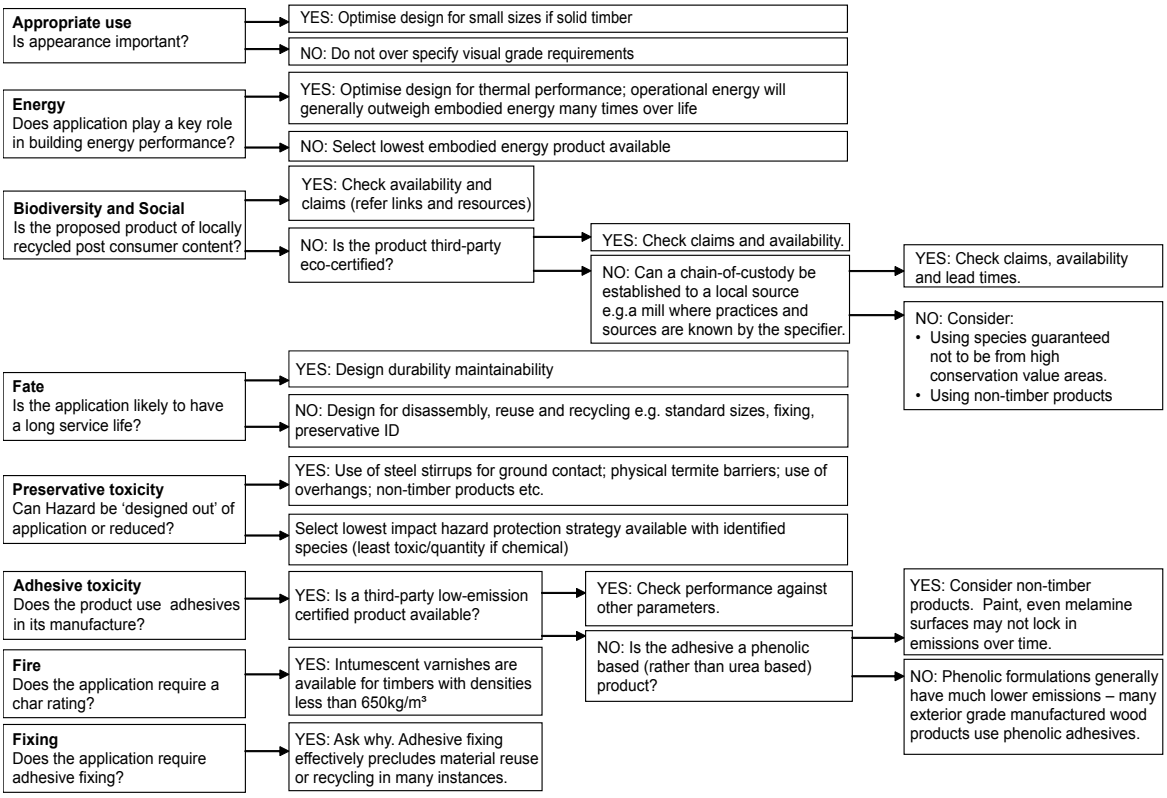

Figure 1. Decision making flow-chart

4.0 KEY ISSUES

The following sections outline the key issues raised in the DFC.

4.1 Appropriate use

Using small sizes of timber up front maximizes choice in species, performance and finish while optimising the design to utilise smaller-dimensioned timber from forests and plantations. Specifying larger solid section sizes increasingly limits species choice, blows out lead times, and increases costs as these sizes are less readily available and typically sourced only from older trees and forests. Larger solid sections (e.g. for boards over 140mm wide, beams over 300mm deep) are not generally a characteristic of regrowth forests or plantations.

Vast quantities of smaller section timber are not recycled as a result of our love affair with larger sections, ensuring that smaller sizes have little or no value. In addition demand for larger section timbers and decreasing public-land supply ensures a ready market for trees to be cut on private land that may or may not have appropriate management controls in place.

The selection of visual grade is a key decision that is entirely in the hands of the specifier. The selection of 'clear' grades (timber that is clear of visual 'defects' such as knots, gum veins and pockets and the like, now commonly referred to as 'feature') increases the likelihood of waste and decreases the likelihood of use of lower 'value' higher-feature wood, often a characteristic of younger regrowth and plantation timbers.

4.2 Biodiversity and social

From the Amazon to Canada's great cedar forests, the devastation caused by logging to ecosystems and associated cultures is well known. Forest destruction continues to escalate, with increasing ramifications as more is removed. It is estimated that 80 per cent of the worlds historic forests cover has been removed already, with an estimated 40 per cent of the remaining 'frontier' or unlogged high-biodiversity forests likely to be destroyed or degraded in the next 10-20 years (Environment News Service, 2002). This is of critical importance with the global replacement of forests by plantations, and the fundamental ecological differences between old-growth (primary/frontier) forests, 'managed' forests, and plantations.

While Australia's forest management is better than many globally, the erosion of forest biodiversity remains a concern. The first *State of the Environment Report* (SOE, 1996) found biodiversity erosion to be one of the most pressing environmental problems in Australia.

While agricultural practices such as land clearing were identified as by far the most destructive practices, forestry was also significant. Ten species were known to be at 'present or future threat of extinction' as a result of forestry practices (State of the Environment Advisory Council, 1996). The report found that 'commercial forestry affects far fewer regions than clearing or grazing and is strongly concentrated in the south-east and south-west. Its overall effects on biodiversity can, however, still be substantial because forests are richer biologically than other terrestrial habitats.' (State of the Environment Advisory Council, 1996). The more recent 2001 SOE report notes the implementation since 1996 of the Regional Forest Agreements (RFA's) but finds significant shortcomings in the approach noting that 'many biologically significant ecosystems and species have not been adequately protected and the efficacy of many forest management prescriptions remain to be determined', (Australian State of the Environment Committee and Environment Australia, 2001).

The desire for independent assessment of sustainability claims, domestically and internationally, and the perception that consumers will differentiate on the basis of environmental assurance, has driven the development of certification schemes and a variety of management initiatives (Drielsma, 2002).

These include the Australian Forestry Standard (AFS) and Forest Stewardship Council Standard (FSC), both forthcoming in Australia. Both standards claim to ensure high levels of environmental stewardship, and will provide 'Chain of Custody', a paper trail linking finished timber to the extraction source to allow verification of claims and build consumer confidence that timbers are not from high conservation-value areas.

Chain of Custody is not a characteristic of RFA timbers. Currently no wood products in Australia (e.g. plantation timbers, EcoSelect) have Chain of Custody. Links and resources to these issues are included at the end of this paper.

4.3 Energy

For buildings, operational energy generally outweighs embodied energy between 10–5:1 (Treloar, McCoubrie et al, 1999; Pears, 2003). However embodied energy remains significant, equivalent to potentially 8 years of commercial office operational energy, especially in highly efficient buildings. It has been calculated that the embodied energy of 60 Leicester St, Melbourne could be equivalent to its operational energy over a 35-year life, i.e. its effective design life (Pears, 2003). The embodied energy of timber and wood products is generally low, and timber is at a further advantage where its insulative properties are of value.

It should be noted in comparisons that differing materials have different characteristics. Timber has good tensile strength, while concrete does not. For optimal comparison these figures should be used in a like-for-like comparison of the final assemblage.

Embodied energy should also be considered in the context of end of life; timber has the opportunity to release energy through combustion if higher reuse options are exhausted. The potential for this can be reduced or removed by the use of preservatives that include toxic heavy metals or chlorinated compounds.

Item	MJ/Kg
Air dried sawn hardwood	0.5
Stabilised earth	0.7
Concrete blocks	1.5
Kiln dried sawn hardwood	2
Clay bricks	2.5
Kiln dried sawn softwood	3.4
AAC	3.6
Plasterboard	4.4
Local dimension granite	5.9
Particleboard	8
Plywood	10.4
Glue-laminated timber	11
Laminated veneer lumber	11
MDF	11.3
Glass	12.7
Hardboard	24.2
Galvanised steel	38
Acrylic paint	61.5
Plastics – general	90
Copper	100
Aluminium	170

Table 3. Embodied energy in wood and other building products
Source: (Commonwealth of Australia, 2002)

4.4 Fate

Some commentators argue that a materials fate is the most useful determinant of whether it is sustainable or not. If a material can be reused and recycled with a comparable degree of efficiency to that found in natural systems, and without degrading natural systems, it demonstrates a high level of sustainability (Sendzimir, Bradley Guy et al, 2001). Fixing, adhesives, and preservatives all impact profoundly on the fate of a wood product, as does the type of paint used, and design decisions affecting the accessibility of the material for maintenance and repair. Recycling and reuse varies considerably with the type of product. Maintenance typically uses much less energy and resources than replacement. Particularly when the design life (e.g. fitout churn) is likely to be short it is important to specify materials appropriate to the situation and their likelihood and potential for high-value reuse.

4.5 Preservative toxicity

By definition of being a natural product, wood is a food source to insects and fungi that can reduce its service life. This brings us to a common conundrum in sustainable timber use: to use naturally durable timber species which are invariably slower growing (typically >100 years optimally), increasingly hard to source and often disastrous to biodiversity e.g. rainforest timbers, or to use fast growing commodity timbers that require the use of chemicals that can greatly reduce the

product's ability to be recycled, reused or down-cycled (e.g. waste to energy) or are simply toxic.

While a comprehensive review is beyond the scope of this document, a wide range of treatments is available, with varying levels of human and environmental toxicity. Very toxic chemicals have historically been introduced into our homes and buildings in the cause of timber treatment such as DDT, Dieldrin, Pentachloraphenol, Lindane, Tributyltin oxide and arsenic. Scientific understanding and public sentiment changes over time, and we are using increasingly sophisticated treatments. The US recently joined a growing list of countries in phasing out the use of CCA treated timber (copper chrome arsenate) for most applications (US EPA). Permethrin, organic zinc compounds, IPBC, Dichlofluanid and Propiconazole are all less toxic than the earlier treatments, although true health and environmental impacts will be apparent only after many years of use.

Product	Use	Advantages	Disadvantages
Boron/Fluorine products	Preservative, fungicide and insecticide. Dry pellet or liquid form. Pellets moisture activated. For H1-H4 applications*	Considered largely benign/ very low toxicity. Commonly available. Low initial cost.	As the products are water soluble, they leach out over timber and must be replenished regularly (often 2-5 years) Widely used in EU in exterior windows and similar applications, in Australia primarily a maintenance product e.g. fence posts.
LOSP (light organic solvent particles) using linseed oil carrier	Preservative, fungicide and insecticide for H1-H3 applications	Avoids use of white-spirit solvent, a greenhouse gas intensive solvent.	May still use Tributyltin Oxide, often banned in marine preservatives due to aquatic toxicity
LOSP	Preservative, fungicide and insecticide for H1-H3 applications	Considered low-toxic, commonly available. Low initial cost. A new formulation is available ('T2') that uses linseed oil instead of white spirit, eliminating the greenhouse impact of white-spirit off-gassing.	Not suitable for in-ground applications. Oil-based primer may be required for painted applications (check with suppliers instructions).
ACQ (ammoniacal copper quaternary)	Preservative, fungicide and insecticide suitable for H1-H5 applications.	Highly effective. Contains no high toxicity arsenic/chromium compounds. Can be burnt and mulched.	Poor availability for most applications but improving slowly. Slightly higher initial dollar cost. Paintable.
Copper Azole	Preservative, fungicide and insecticide suitable for H1-H4 applications.	Highly effective. Contains no high toxicity arsenic/chromium compounds. Can be burnt and mulched.	Poor availability for most applications but improving slowly. Slightly higher initial dollar cost. Paintable.
CCA (copper chrome arsenate solution) (tanalized) Available water/ oil base	Preservative, fungicide and insecticide suitable for H1-H6 applications.	Lowest initial dollar cost, paintable, highly effective. Oil based variant offers improved resistance to surface weathering of timber.	Cannot be safely disposed of except as landfill: highly toxic smoke from burning, cannot be mulched. Not presently reusable for timber products e.g. particleboards, although research continuing. Any shavings and offcuts must be disposed of as landfill. Effectively prohibited in Japan and some European countries and undergoing, phase-out in US. Some research shows significant toxicity from contact to treated timber to children under 6 years (Environmental Working Group, 2001).
PEC (pigmented emulsified creosote)	Preservative, fungicide and insecticide suitable for in-ground applications.	Emulsified form of traditional Creosote. Highly effective, lower toxicity, may be disposed of by incineration.	Cannot be painted. Still considered quite toxic, generally used for agricultural applications.
Creosote	Preservative, fungicide and insecticide suitable for H4-H6 applications.	High efficacy.	High toxicity and restricted use (e.g. for farm posts). A known carcinogen. Cannot be painted. Strong smelling.

Table 4. Preservatives used in the treatment of wood
Note: a list of environmentally preferable treatments and suppliers may be found in www.ecospecifier.org
*Applications are attributed 'Hazard' levels under Australian Standards. These range from 'H1' (above ground, indoors and protected) to 'H6',(timber permanently in contact with salt water). Windows are typically a H3 application (outside but not in-ground), while fences (in ground contact) typically a H4.

4.6 Binder toxicity

Many wood products today incorporate formaldehyde-based glues. The US Environmental Protection Agency has classified formaldehyde as a 'probable human carcinogen'. In many commonly used forms formaldehyde will off gas, particularly in new products and in high heat and humidity. Inhalation of formaldehyde vapours can cause fatigue, respiratory irritation, allergic skin reactions and is a probable carcinogen (IARC, 2003). Many Australian building sites today have clean-air rooms specifically to cut MDF and other formaldehyde glue-incorporating products.

Conventional interior grade products (plywoods, MDF's, particleboards) typically use urea-formaldehyde (UF) glues, which are relatively unstable and off gas consistently over time. According to the CSIRO this off gassing is not stopped for more than a matter of weeks by painting, varnishing or laminating surfaces (Brown, pers comm, 2003). These materials are a primary contributor to formaldehyde emission concerns in buildings (Brown 2001).

Plywoods used for exterior and structural applications typically use phenol formaldehyde (PF) resin. PF is a more expensive water-resistant glue, and a much more stable product that off gasses at a much lesser rate than UF glue. It should be noted that some Australian manufacturer's are now exporting MDF products with half the emissions levels of domestic product, such as that required by the Japanese 'E0' standard (E0 refers to the Japanese standard and an emission level of 0.5mg/litre. The Australian Standard is for 1mg/litre. Japan has recently passed a new standard, JIS A5908, which requires emissions under 0.3mg/litre). To date these products have not been mass-marketed to the domestic marketplace. Zero-formaldehyde products (using non-formaldehyde binders) are widely available in the EU and US, and at least one company is importing small quantities to Australia, although a 30 per cent cost impost applies.

4.7 Fixing

Australia is currently enjoying a modest but fast-depleting resource of recycled timber. This is gradually coming to an end partly due to the use in recent decades of adhesive fixings. While deconstructability is fundamental to reuse and high-value recycling, current glue and nail practices will ensure this is in most instances impractical, and repair difficult. It is critical wherever possible to use fixings that facilitate deconstruction and high-value reuse.

5.0 GUIDE TO APPLICATIONS

The following tables overview timbers, treatments, and other relevant issues against common applications.

5.1 Decking

Appropriate use	Decking is one of the most testing applications for timber, where its visual qualities are quickly lost, and where it typically receives little or no care. Consider using non-premium grades of timber, and durable non-timber (e.g. tiles) and composite products (e.g. www.modwood.com.au) that maintain their look and display the less-thermally conductive qualities of timber.
Biodiversity and social	• Commonly used imported rainforest species e.g. Merbau is typically uncertified. Not generally possible to determine that timber does not come from illegally logged areas. • Fit for purpose RFA timbers include Jarrah, Blackbutt, and Turpentine. Many commonly specified species e.g. Yellow Box, are sourced from private land where conservation management can come under less scrutiny. • Termite resistant cypress pine is sourced from Queensland state forest estate and private forests. • FSC/AFS timbers; contact suppliers for appropriate timbers. • Plantation radiata, slash and hoop pine is suitable but only if preservative treated. Plantation hardwoods are available in small quantities e.g. Sugar Gum (Victoria) Sydney Blue Gum (Melbourne and Sydney from NZ through Mathew's Timber). • NSW State Forests asserts that many hardwood species are plantation grown. However chain-of-custody is not available and assurance of origin is not generally possible. • Wood plastic composites may use plantation sawdust as 'modwood' currently states they do.
Energy	Typically NA for operational energy. Preservative treated timbers will have a higher embodied energy.
Fate	Generally poor reuse opportunities for timber decking so biodegradability or fuel conversion capability important. CCA timber cannot be burnt or disposed of except in landfill. Encouraging the user to regularly reapply decking oils can greatly extend appearance and service life.
Preservative toxicity	CCA alternatives and LOSP are available in major centres. If using CCA specify the minimum required – H3 for above ground timbers.
Adhesive toxicity	Typically NA
Fixing	Typically mechanically fixed via screwing or nailing, both of which may be removed. Screw fixings may be preferable for deconstructability.

5.2 Windows and doors – external

Appropriate use	Particularly in exterior applications windows and doors generally require a high-value clear-grained timber to maximise potential durability and lifespan in first and subsequent design lives.
Biodiversity and social	• Imported rainforest species e.g. Merbau and Meranti are typically uncertified. These species are listed as vulnerable, endangered and critically endangered by Friends of the Earth UK (FOE UK, 2003). • There are a wide variety of fit for purpose RFA timbers including Messmate, Mountain Ash, Sydney Blue Gum, Jarrah. • FSC/AFS timbers; contact suppliers for appropriate timbers. • Plantation Hoop, slash and radiata pine are suitable but generally used in Australia only if LOSP preservative treated. Radiata and slash pine products available only in pre-primed products (e.g. Canterbury windows, Sydney). Hoop pine windows available in unpainted form (e.g. Finlaysons, Brisbane, which makes the only commodity plantation timber exterior doors in Australia to the author's knowledge). The wide use of untreated painted pine in EU with borate plugs incorporated (Camden City Council, 2003) suggests preferences may be cultural as much as technical. • Plantation hardwoods are available in small quantities e.g. Sugar Gum (Victoria) Sydney Blue Gum (Melbourne and Sydney from New Zealand). Other plantation hardwoods as per 'Decking' above.
Energy	Solid wood products have similar thermal resistivities. Frame thermal conductivity can dramatically affect building efficiency (Commonwealth of Australia, 2002).
Fate	Timber windows and doors can have long and repeated lives with care and maintenance. Boron based preservatives are preferable to LOSP from a disposal/reuse of timber perspective, and has lower toxicity, but requires periodic reapplication. LOSP requires reapplication to any cut areas or after sanding/refinishing. Access for repair and maintenance is critical for long life.
Preservative toxicity	As per Fate.
Adhesive toxicity	Typically NA
Fixing	Typically gluing and traditional joinery techniques. Design for disassembly (e.g. sill replacement) where possible.

5.3 Windows and doors – internal

Appropriate use	Use the lowest level of visual grade as appropriate.
Biodiversity and social	• Imported rainforest species e.g. Merbau, Meranti are typically found in a wide variety of solid and core doors. Conservation status as noted above. • There is a wide variety of fit for purpose RFA timbers for this application. • FSC/AFS timbers; contact suppliers for appropriate timbers. • Plantation Hoop, slash and radiata pine are suitable. • Plantation hardwoods are available in small quantities as per windows-exterior above.
Energy	Generally not a significant issue, although timber is much less energy intensive than other common materials.
Fate	Can have long and repeated life with care and maintenance. Lightweight composite doors tend to have single-use lives, while more expensive joinered doors (often using more material by weight) are more likely to be reused.
Preservative toxicity	Generally NA
Adhesive toxicity	Interior doors may use quantities of glues in their assembly. This application is not known to be a high-priority indoor environment quality issue at this time.
Fixing	Typically gluing and traditional joinery techniques. Timber sections are typically too small to be reused or recycled except as doors and windows.

5.4 Flooring

Appropriate use	Flooring can be a high-value, long and repeat life application. Consider using high-feature products. Pre-finished systems can make efficient use of natural resources through the use of commodity plantation timber substrates and high-value timbers for veneers only.
Biodiversity and social	• Imported species e.g. Mahogany, Teak, Anegre are typically uncertified. These species are listed as vulnerable and endangered (FOE UK, 2003; Rainforest Action Network, 2003) by conservation groups. Baltic pine is widely used, although there is strong evidence that sources e.g. in Baltic Russia, are far from sustainable (Environment News Service, 2002). • There is a wide variety of fit for purpose RFA timbers for all applications including Blackbutt, Cypress, Spotted Gum, Brushbox, Jarrah, and Tasmanian Oak. Brushbox is a rainforest gully species and is often sourced from private land. • FSC/AFS timbers; contact suppliers for appropriate timbers. • Plantation Hoop, slash and radiata pine are suitable but generally considered commodity flooring solutions. • Plantation hardwoods are available in small quantities e.g. Sugar Gum (Victoria) Sydney Blue Gum (Melbourne and Sydney from New Zealand). Parquetry plantation Sydney Blue Gum is available from Portugal through 'Premium Cork & Timber'. Other plantation hardwoods as per 'Decking' above. • Wide range of recycled and re-machined hardwood and softwood timbers. • Bamboo can be an excellent, very hard-wearing alternative.
Energy	Air leakage through joist and bearer timber floor systems can be a considerable source of inefficiency. Appropriate detailing and the use of insulating solutions e.g. inter-joist reflective films can best address this.
Fate	First-use: Tongue and groove (T&G), parquetry and pre-finished systems have the most capacity for a long first-use life. Panel products (e.g. plywoods) durability can be dictated by wear and the impact resistance of the finishing coat e.g. epoxy. Repair/re-use: all systems are prejudiced from reuse by use of glue in application. T&G floors have highest intrinsic potential for repeat re-use and repair. Disposal: Pre-finished floors may use polyester or other wear/impact resistant additives which, in addition to composite structure and gluing limit any disposal option but landfill. Potential environmental toxicity is generally unquantified. Parquetry and T&G floors disposal options depend on glues, finishes and fixing of any co-joined substrates at removal. Panel products may be highly biodegradable or less depending on the glue-bond used. Marine-grade glues degrade over decades or longer.
Preservative toxicity	Panel products may incorporate LOSP treatments to prevent termite attack. Use physical non-toxic barriers (e.g. granite-guard, termi-mesh) where possible.
Adhesive toxicity	Particleboard flooring and interior-grade ply products (including bamboo) typically use urea formaldehyde glues and can be a significant source of off-gassed VOC's.
Fixing	Gluing is typically used to speed or aid fixing, or to reduce squeaks. It is often, in particular with T&G profiles, not required. If at all possible nail only. Fixing hardwood boards to softwood joists is achieved with longer and/or high-grip nail profiles.

5.5 Structural framing – external

Appropriate use	Specify requisite structural grade, lowest appearance grade.
Biodiversity and social	• Imported species e.g. Oregon are typically uncertified. Approximately 90 per cent of the US's old-growth Douglas Fir forests have been logged with more scheduled for logging (Noss, LaRoe et al, 1995). Western Red Cedar is a temperate rainforest species whose conservation status in many communities is endangered (reference e.g. http://www.fscstandards.org/regions/pacific/appendix_d.html). For a stark map of US reserves refer to Earthwatch Europe, IUCN et al. • There is a wide variety of fit for purpose RFA timbers depending on stress grading and durability required including Messmate, Cypress Pine, Jarrah, Tasmanian Oak, Turpentine and Tallowwood. These species are also sourced from private land. • FSC/AFS timbers; contact suppliers for appropriate timbers. • Plantation Hoop, slash and radiata pine are ubiquitous. • Plantation hardwoods are available in small quantities e.g. Sugar Gum (Victoria) Sydney Blue Gum (Melbourne and Sydney from New Zealand). Other plantation hardwoods as in section 5.1 Decking.
Energy	Timber is not an outstanding insulator, but is far better than thermally un-broken aluminium.

Fate	Oregon is a non-durable timber that is widely used and treated as if it is durable. It typically has a short life. CCA-treated pine is a disposal liability as noted. Naturally durable hardwoods have a high chance of high-value reuse if protected. Demountable mechanical fixing facilitates maintenance.
Preservative toxicity	CCA alternatives are available for most applications with supply expected to increase from mid 2003. Design-out the need for preservatives where possible using physical barriers e.g. galvanised stirrups, termite barriers.
Adhesive toxicity	Not generally an issue.
Fixing	Removable mechanical fixing e.g. screws, bolts, facilitate disassembly.

5.6 Structural framing – internal

Appropriate use	Specify requisite structural grade, lowest appearance grade.
Biodiversity and social	• Imported species: refer framing-external. • There is a wide variety of fit for purpose RFA timbers for solid, ply and laminated applications including Messmate, Spotted Gum, Cypress Pine, Jarrah, Tasmanian Oak. Also sourced from private land. • FSC/AFS timbers; contact suppliers for appropriate timbers. • Plantation Hoop, slash and radiata pine are available in solid, ply and laminated profiles and suitable for common applications including bearers and joists. Mechanical fixing to these timbers is not problematic. • Plantation hardwoods are available in small quantities e.g. Sugar Gum (Victoria) Sydney Blue Gum (Melbourne and Sydney from New Zealand). Parquetry plantation Sydney Blue Gum is available from Portugal through 'Premium Cork & Timber'. Other plantation hardwoods as per 'Decking'.
Energy	Not typically an issue as wood has relatively low thermal conductivity ≈0.1-0.15 W/m°C for timber compared to 47.5 W/m°C for steel, 220 W/m°C for aluminium.
Fate	Fate is typically determined by fixing system, use of preservatives, and size and type of timber section. Small, laminated, and non-standard sizes are unlikely to be reused. The increasing use of laminated, reinforced and composite timbers incorporating steel are decreasing the likelihood of reuse or recycling especially in conjunction with glue and nail systems.
Preservative toxicity	Panel products may incorporate LOSP treatments to prevent termite attack. Use physical non-toxic barriers (e.g. granite-guard, termimesh) where possible.
Adhesive toxicity	Not typically applicable.
Fixing	Typically glued and nailed. Use mechanical fixing only where possible.

5.7 Decorative veneers

Appropriate use	Decorative natural veneers come in two principal forms: quarter cut and crown cut. Quarter-cut require larger trees while crown cut veneers are more suited to smaller trees from regrowth forests and plantations (Briggs Veneers). Also available are reconstituted timber veneers that are made to replicate the appearance of quarter and crown cut veneers.
Biodiversity and social	• There is a wide range of imported species e.g. Maple, Rimu, Mahogany, Teak, Ebony, typically uncertified. Many are associated with vulnerable forest types, and ensuring sustainability of source is typically not possible. • There is a wide variety of fit for purpose RFA timbers including Messmate, Jarrah, Tasmanian Oak, Brushbox, Myrtle, Sassafras, Celery Top Pine. Many of these species are also sourced from private land. • No FSC/AFS veneers are available at the time of writing. • Plantation Hoop and radiata pine are available. A wide range of Italian poplar-based reconstituted wood veneers and solid-edges are available through import. • Plantation local hardwoods are either not commercially available or the chain of custody is not clear. Farm forestry Sugar Gum (Victoria) is available in very small quantities.
Energy	Not typically an issue.
Fate	Except in furniture applications veneer is unlikely to be reused or recycled. Reuse potential is extremely limited. For this reason in applications with a high churn in particular the use of natural veneers with potential or present conservation concerns should be minimised.
Preservative toxicity	NA
Adhesive toxicity	Not generally an issue. Manufactured veneers typically use urea-based glues and will have higher product emission levels than natural veneers.
Fixing	Gluing only.

5.8 Joinery, also including skirting boards, architraves and trims

Appropriate use	Balance predicted application life and likely fate against other considerations such as potential biodiversity impacts in the selection of manufactured/solid products. Use high-feature grade if low-feature grade is not required.
Biodiversity and social	• Imported species: refer framing-external. • There is a wide variety of fit for purpose RFA timbers for solid, ply and laminated applications including Messmate, Spotted Gum, Cypress Pine, Jarrah, Tasmanian Oak. Also sourced from private land. • FSC/AFS timbers; contact suppliers for appropriate timbers. • Plantation Hoop, slash and radiata pine are typically used in manufactured products including MDF, particleboard. • Plantation hardwoods are available in small quantities e.g. Sugar Gum (Victoria) Sydney Blue Gum (Melbourne and Sydney from New Zealand). Parquetry plantation Sydney Blue Gum available from Portugal through 'Premium Cork & Timber'. Other plantation hardwoods as in section 5.1 'Decking'.
Energy	Not typically an issue.
Fate	A great deal of purpose-made fixed joinery products, such as retail and kitchen fitouts, are unlikely to be recycled. They are made to specific requirements and dimensions and are not readily modified. Some office products (e.g. bookshelves) are more likely to be reused. However co-mingling of products such as wood panels, melamines, laminates and steel fixings usually makes recycling impractical, the low unit value of the product makes disassembly unattractive, and glue-fixing and poor repeated-mechanical fixing characteristics of wood panel products make disassembly impractical. Landfill is the likely fate of most fixed joinery.
Preservative toxicity	NA
Adhesive toxicity	Three Australian manufacturers make an MDF product for export that has approximately half the emissions of the Australian E1 standard (Bone, 2002). Zero formaldehyde MDF products are available on import. Marine grade ply products typically have significantly lower emission levels, but higher costs. Published figures are not available on proprietary brands actual emissions.
Fixing	Gluing only

6.0 LINKS AND RESOURCES

Alaskan Conservation Foundation

For a local perspective on forest status in Alaska where some of our Oregon comes from this excellent site has both slide shows and audio tours:

http://www.akrain.org/rainforest/info/logging.asp

AFFA

The federal resource on the AFS
http://www.forestrystandard.org.au/

Certifiedwood.org

A site that has both industry and conservation group interests represented and provides an excellent introduction to certification as well as a powerful search tool for timbers and distributors of certified forest products globally.
http://www.certifiedwood.org

Ecospecifier

An Australian guide to eco-preferable products and materials with decision-making guides and detailed product information.
www.ecospecifier.org

EU Wood Products

For a conservation perspective on European wood products:
www.fern.org

FAO

For a global UN perspective and a wealth of general forestry facts and figures:
http://www.fao.org/forestry/index.jsp

Forest Conservation Portal

Perhaps the leading global compendium of articles, information access and links to forest-related conservation material.
www.forests.org

Forest Stewardship Council

The international agency web site:
http://www.fscoax.org/

Friends of the Earth UK Good Wood Guide

A global guide to forest and timber species conservation status from a leading international conservation group in this field.

Follow the links from www.foe.co.uk (search for 'Good Wood')

National Association of Forest Industries

The peak industry body with regard to a broad range of issues including certification.
www.nafi.com.au

One Stop Timbershop

A Wilderness Society Internet site profiling endorsed timber and wood products, with the links and resources to supplying merchants.
www.timbershop.org

Rainforest Information Centre Good Wood Guide (Australia)

For a domestic conservation group perspective and thorough resource: http://www.rainforestinfo.org.au/good_wood/contents.htm.

Timber in Context

Willis, A & Tonkin, C, 1998, *Timber in Context - a Guide to Sustainable Use*, Construction Information Systems Australia, NSW, Australia.

REFERENCES

Australian Bureau Of Statistics, 2002, *Year Book Australia 2002: Forestry and Fishing Wood and Paper Products*, 2003, October 19.

Australian State of Environment Committee, 2001, *Australia State of the Environment 2001*, CSIRO Publishing on behalf of the Department of the Environment and Heritage, Canberra CD-ROM, http://www.deh.gov.au/soe/2001/index.html.

Bone, K, 2002, *Personal Communication with Dominance Industries*, A Walker-Morison, Melbourne.

Briggs Veneers, 2002, *Wood Veneer Cutting Methods and Veneer Characteristics*, 2003, Aug 9, http://www.ecoveneer.com/veneer.cfm.

Brown, SK, 2001, *Building with Low Indoor Air Polluting Materials and Appliances,* Melbourne, CSIRO.

Camden City Council, 2003, *Green Buildings Guide*, 2003, August 9, http://www.camden.gov.uk/.

Clark, J, 1995, *Australia's Plantations: A Report to The State Conservation Councils,* Melbourne, Environment Victoria.

Commonwealth of Australia, 2002, *Your Home,* Canberra, Australian Greenhouse Office.

Drielsma, JH, 2002, *The Australian Forestry Standard: A New Era for Sustainable Forest Management in Australia*, Australian Forest Growers Conference, Albany, AFG.

Earthwatch Europe, IUCN, et al, 2002, *Business & Biodiversity: The Handbook for Corporate Action*, *Geneva*, IUCN.

Environmental News Service, 2002, 2003, October 19, http://www.ens-newswire.com/.

Environmental Working Group, 2001, *Poisoned Playgrounds*, 2003, October 19, http://www.ewg.org/reports/poisonedplaygrounds/.

Federal Goverment of Australia, 2002, *3.1 Embodied Energy,* 2003, June 14, http://www.greenhouse.gov.au/yourhome/technical/fs31_2.htm.

2002, *Myth of World Forest Cover Shattered*, 2003, October 19, http://www.greencrossinternational.net/digitalforum/digiforum/articles/article2002/Mythofworld.html.

2001, *Poisoned Playgrounds,* November 2002, http://www.Ewg.Org/Reports/Poisonedplaygrounds/.

Friends of the Earth UK, 2003, *Good Wood Guide,* 2003, August 9, http://www.foe.co.uk/campaigns/biodiversity/resource/good_wood_guide/wood_timber_types_a_to_g.html.

IARC, 2003, *List of IARC Evaluations*, 2003, October 19, http://monographs.iarc.fr/monoeval/grlist.html.

Noss, RF, Laroe, ET, et al, 1995, *Endangered Ecosystems of the United States: A Preliminary Assessment of Loss and Degradation*, Washington DC, USDI National Biological Service.

Pears, A, 2003, *Embodied Energy vs Operational Energy,* A Walker-Morison, Melbourne.

Rainforest Action Network, 2003, *What not to Buy*, 2003, August 9, http://www.ran.org/ran_campaigns/old_growth/forestworld.html.

Sendzimir, JG, Bradley Guy, et al, 2001, *Construction Ecology: Nature as a Basis for Green Buildings*, Spon Press.

State of the Environment Advisory Council, 1996, *Australia State of the Environment 1996*, Canberra, Commonwealth of Australia.

Treloar, GJA, Mccoubrie, et al, 1999, *Embodied Energy Analysis of Fixtures, Fittings and Furniture in Office Buildings Facilities* 17(11): 403-409.

US EPA, 1990, *Reducing Risk: Setting Priorities and Strategies for Environmental Protection*, US EPA.

BIOGRAPHY

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