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New Applications of Timber in Non-traditional Market Segments: High Rise Residential and Non-residential (commercial) Buildings

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New Applications of Timber in Non-traditional market segments: High Rise Residential and non-residential (commercial) Buildings

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EXECUTIVE SUMMARY

Most of the timber used in the Australian built environment is presently for low-rise residential construction. This market share is under constant erosion from competitive systems; therefore, entry into non-traditional sectors would benefit the industry through a wider market portfolio of building type applications, and a higher value product system development. Promising international applications for timber market expansion have shown potential, in particular, for in-fill framing and interior furniture and fit-out markets in the medium to high-rise residential and commercial buildings (particularly masonry). An earlier report (PN05.1020) identified reasons for the lack of timber use in the non-residential sector, and identified areas for the industry to focus on, including commercial, infill and fit-out markets. There exists a large opportunity in these non-traditional sectors for timber applications, however, present product offerings may not be suitable in their present form. This report outlines the size of the market and values of timber systems presently used in these sectors and potential growth scenarios, together with directives on how industry can take advantage of the market potential for timber options, and instigate a platform for development of suitable wood product offerings.

The project analysed building designs in order to estimate the size and value of the market sector in commercial and high-rise residential buildings; established the major building systems used in these sectors, and why these systems are popular (major attractiveness of current systems) and scoped two current timber systems that have the opportunity to increase timber volumes in these markets.

Project Objectives

The FWPA, in consultation with industry, conceived a project to identify the best return to industry of new timber applications in high rise residential buildings and non- residential(commercial buildings (both low and high rise). The project was perceived necessary as an earlier report by Bayne and Taylor (2005) had indicated by qualitative analysis, a number of potential non-residential market segments where timber could grow market share, however the potential had not been quantified. This project was therefore established to quantify the size of the most prospective market segments for timber in these identified sectors, with the analysis of these new timber applications

including technical limitations and channels to increase the understanding of timber use in these segments in Australia.

A project consisting of literature and desktop research, surveys and analysis of building blueprint designs in consultation with specifiers, and a workshop with industry experts to assess promising applications for timber was conceived, which had the following objectives:
a) Identify the most promising market segments for timber within 3 major building segments:

- high rise residential (structural infill and non-structural fit-out)
- high rise commercial (non-structural fit-out)
- and low rise commercial (structural and non-structural fit-out)

b) Quantify the market size for timber capture in each of these three segments by evaluating total build volume and value, and current material usage statistics.
c) Provide recommended new timber applications in these areas and outline priority areas to address in terms of reducing barriers to entry in each of these 5 sectors.

Key results

The predominant building types, in terms of total value work, are medium-high rise apartments, followed by retail/ wholesale buildings, offices and industrial buildings. The main potential for timber increase is in medium to high rise apartments (mainly partitions), and in education and health/ aged care buildings (structural systems).

Given a potential increase from market initiatives, timber volumes used in these sectors in Australia are expected to increase from 283,000 cubic metres of timber for the March 2007 year to 346,000 cubic metres of timber for the March 2008 year, this number would then increase up to 725,000 cubic metres of timber for the March 2014 year.New Zealand timber market share is at least a third higher and for some building types (education, entertainment, and accommodation) is more than double the percentages used for Australia. The current timber volume used in non-residential buildings is about the same for both countries (~250,000m3), despite much larger volumes of work being undertaken in Australia.

In most cases the respondent (mainly quantity surveyors) found it difficult to judge if the main frame could be replaced by timber, and hence they made little comment. There appears to be an opportunity for educating QS on the

abilities and usage situations of timber framing, particularly relating to structural applications outside of residential usage.

Systems choice is complex, many decision makers are involved, and systems are rarely chosen on individual merits alone, usually experience, market dominance, project idiosyncrasies and financial risk play a large part in systems and material choice. Major construction projects are aiming to reduce schedules, improve quality and accuracy and reduce risk. Offsite prefabrication by a number of systems is attractive due to reduced build times, less onsite waste and therefore increased site safety. Concrete systems still dominate the high-rise sector, and tilt-slab is making significant inroads in the low-rise sectors also. Concrete is maintaining good market share through utilising innovative international franchise systems. Collaboration early on in the project conception leads to the ability by steel to optimise the design and reduce build time and cost. Presenting demonstrable results to building owners and developers has also been key to growth of steel in this sector, unlocking entry to a range of other tender opportunities.

There has been a recent push by the steel industry to combat concrete strength in the multi-level sector through the "Framing the Future campaign". This appears to be paying off in terms of market share, growing from 3% in 2003 to 13% in 2005. Interestingly, the steel sector noted several similar barriers to entry to those identified by the timber sector. The growth in steel market share is said to be due to speed of construction; versatility and adaptability of design and good design documentation.
In the low-rise sector, modular systems are attractive, suitable for framing systems, and tilt-up systems due to speed, simple tools and no onsite waste; while in the high-rise office sector, tenantable space is key, and the modularity and grid layout of steel combined with excellent spanning allows cost-competitiveness. High-rise hotels and apartments find concrete systems attractive due to the acoustic and fire separations, less need for HVAC systems and minimal additional interior fitout and panelling required.

While the residential market is currently in a downturn, good opportunities in the apartments sectors are medium term in Tasmania, Sydney and Perth, while Vic does not show good prospects. Short-term, ACT, NT and NSW are still holding good prospects. There are excellent med-longterm prospects for aged care facilities, particularly in WA and NT, and for the no-residential sector as a whole in Sydney. SA and Tasmania do not show good prospects.

Two promising applications emerged from a workshop to investigate potential timber systems that the Australian industry might adopt or modify for the market environment:

- Cassette Flooring consists of prefabricated light weight timber flooring modules for upper-storey flooring of low-rise (1-3 storey) buildings. This is an opportunity for the prenail wall frame and roof-truss operations to expand their business and provide a prenail flooring cassette, and an opportunity for the timber suppliers of high-grade framing, LVL, I-joist, particleboard and plywood to increase timber supplies into the prenail marketplace. There appears to be a sizeable opportunity for such a system, which would not only increase the penetration of timber systems into the low-rise commercial sector, but includes spin-off benefits in terms of site safe practices, environmental benefits and star ratings opportunities, and offering a solution for current building skill shortage through factory-based construction.
- Access floors contain a system that delivers heating, ventilation and air conditioning (HVAC), electrical power, cabling, and other utility services underneath an accessible, flexible modular floor, that is load bearing but a non-structural infill. The floor consists of a series of panels that are held at the corners by steel or polymer moulded pedestals. The pedestals are attached to the main structural base by adhesive, and the panels are screwed or clipped into these pedestals for easy access and removal. The panels often have cut-outs and plastic fittings where wires can be accessed, or grills are placed.The potential floor area that the system could be used in (for med-high rise apartments and office buildings) is estimated at 6,825,000sq m: 3,107,000 sq metres for apartments and 3,718,000 sq metres for offices.There are already three suppliers of access flooring in the Australian market, two are manufacturers (Tasman and ASP), and Tasman manufactures a wood-based panel product.

Recommended actions

The cassette flooring system that would be of most benefit in an Australian sector is an I-joist box construction, open at the ceiling, with either ply or particleboard flooring. This system utilises the recent timber marketing efforts into engineered wooden I-beam flooring products as a solution to squeaking floors, allows an incremental improvement over joist and hanger systems (i.e. not jumping straight to a fully automated and insulated cassette) while introducing the prefabricated timber floor concept to the building sector. There is vast knowledge to be gained from the UK timber flooring

offsite production sector, and the industry should build on the knowledge gained to date by this UK timber industry. Likely market size shows that there is a potential for around 3,000 m3 of timber flooring cassette product to be used in non-traditional market sectors via this system per annum. This is an opportunity for particularly the Frame and Truss industry to explore further, and utilise existing supply channels for prefabricated flooring, in a similar manner to prefabricated truss and wall frame.

The recommended route for the timber industry to further access flooring is to partner with the suppliers, and to link the concept with a hardwood flooring initiative. The opportunities to expand timber in the sector therefore exist in a partnering deal with these suppliers to a) improve wood core material to be used in places currently used by cementious or steel panels; and b) use timber as an overlay for the existing systems. Much more work is required in scoping the potential for a partnering opportunity before any detailed business case can be completed. Initial discussions need to be held with existing Access flooring suppliers in the Australian market, and the timber hardwood veneer and board suppliers, and as a result of these discussions, a detailed business strategy prepared.

Australian Non-residential Market Trends

The Australian Yearbook[1] shows non-residential building activity to be 33% of total construction activity, with the biggest recent sector growth in the aged-care market.

Apartments and Multi-units are highly valuable, and high-growth building types. The predominant non-residential building types of today, in terms of total value work, are retail/ wholesale buildings, offices and industrial buildings (Table 1). Those building types expected to make significant increases in the value of work placed between 2007 and 2014 are Accommodation (66%); Educational (44%); and Health and aged care (44%) facilities.

Building activity forecasts - value of work placed

	$ million constant 06/07$											
March years	**03**	**04**	**05**	**06**	**07**	**08**	**09**	**10**	**11**	**12**	**13**	**14**
Med-High Rise Apartments	6,282	6,755	6,776	6,123	5,592	6,148	6,821	7,275	7,887	8,613	9,180	9,596
Low-rise multi-units	5,570	5,990	6,009	5,430	4,959	5,452	6,049	6,452	6,994	7,638	8,141	8,510
Retail/Wholesale trade	3,976	4,024	4,303	5,079	4,973	5,271	5,194	5,381	5,560	5,805	6,010	6,160
Offices	3,844	4,560	4,428	5,000	5,949	6,514	6,124	5,940	5,876	6,004	6,325	6,687
Other commercial	691	611	791	802	861	770	734	791	841	890	934	972
Industrial	3,298	3,376	3,905	4,492	4,698	4,381	4,363	4,511	4,693	4,890	5,080	5,246
Educational	2,548	2,639	2,560	3,065	3,146	3,388	3,581	3,771	3,905	4,080	4,303	4,533
Health and aged care	2,194	2,164	2,037	2,004	2,540	2,740	2,908	3,050	3,180	3,324	3,484	3,651
Entertainment and recreation	1,758	1,446	1,468	1,578	1,671	1,706	1,697	1,728	1,793	1,885	1,998	2,126
Accommodation	946	1,039	1,163	1,352	1,218	1,289	1,444	1,562	1,676	1,792	1,907	2,018
Miscellaneous	951	1,037	1,221	1,508	1,969	1,731	1,603	1,591	1,629	1,700	1,796	1,910
Total	32,057	33,642	34,661	36,432	37,576	39,391	40,517	42,053	44,033	46,621	49,159	51,408

Source: Construction Forecasting Council

Table 1: Value of building work

Sectoral Growth

The Australian Construction Industry forum reports[2] for 2006-2007 show trends for various Australian building sectors.

High-rise commercial

Office building is falling off a cyclical high of 10% growth per annum over the past 8 years, but will continue at 5% growth per annum short-term, and 3% per annum long-term. Non-residential building activity is expected to peak during 2007/08 as industry reaches boom levels, which will offset any

[1] The Australian Yearbook 2006

[2] Available at http://www.cfc.acif.com.au/

residential downturn. Commercial building figures in NSW are expected to remain high through 2008, and once again Sydney will overtake Melbourne in non-residential spending (the latter being strong recently due to a high number of retail and office complexes constructed). In contrast Tasmanian non-residential approvals will require greater Government spending on infrastructure, as there is no base level work in non-residential coming through.

High-rise residential

Australian residential demand as a whole has been dropping 3-4% per annum since 2005, however, this still represents a reasonable level of demand. Residential construction is expected to increase during 2007, supported by low unemployment and solid migration. High rise residential growth is driven by stable interest rates; migration; pent-up demand and long-term visitor numbers. Long-term visitor numbers drive up rental markets, which in turn increase property investment levels. The levels of migration alone could move dwelling units from 140,000 to 169,000 over the next 5 years[3]. The apartment market will therefore be hard hit in the short-term but will recover mid-longterm. The Victorian apartment market will be very hard hit short term but is likely to recover long term, while NT will do very poorly short-term. Limited dwelling commencements due to the lack of affordability are affecting WA, and no change is anticipated before 2008. In contrast, a strong rise in apartment spending is expected to continue mid-long term, in Tasmania, where dwelling approvals were up 25.5% in March 2007, but this was not reflected in increased high-rise spending[4]. Anticipations are that pent-up demand in NSW could drive residential build spending to higher than expected starts over the short term. Similarly, Queensland dwelling commencements are expected to rise during 2007/ 08 due to pent-up housing demand.

Low-rise commercial

While NT, WA and Sydney will show strong non-residential sector growth for low rise buildings, Adelaide, Hobart, Brisbane and the non-metro areas of Victoria and South Australia will show poor growth in construction spending over the short-medium term. Health and aged care facilities should experience the largest growth over the short-medium term, rising from a 3.2% growth per annum to 8.4% growth per annum, and will stabilise at 6% per annum in the longterm. The Australian Bureau of Statistics releases monthly

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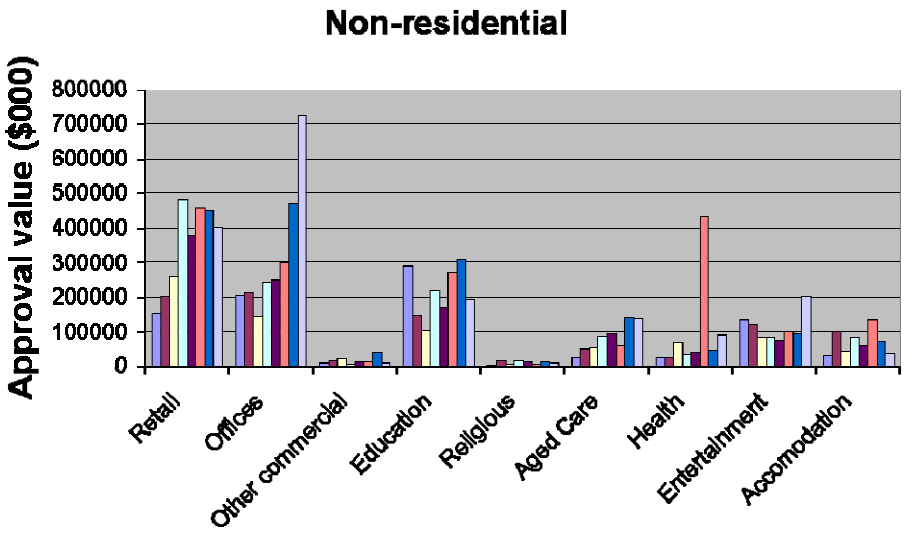
[3] Asia Pulse News, 19 Jan 2006 " Australia's residential building activity set to slow"

[4] ABC News, 8 May 2007 "Housing approvals up but non-residential down"

building approval figures for various non-residential applications. June building approvals by application, for the last seven years (2000- 2007) (Figure 1) shows the growth of retail, offices and aged care facilities during this time, while health, education and entertainment facilities are steady or cyclical:

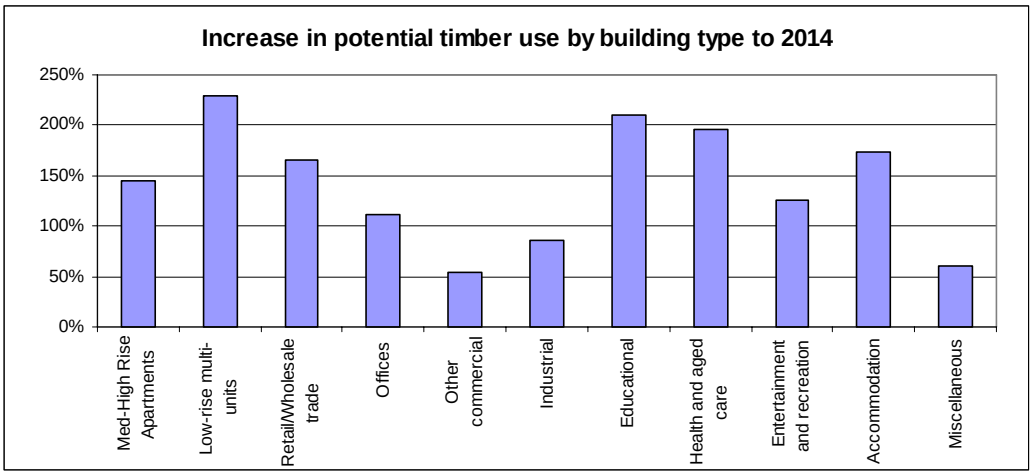
Figure 1: June building approvals by building type 2000 -2007



Current and Potential market growth for timber in the non-residential sector

The current volume of structural sawn timber used in non-residential building construction is estimated at 283,000 cum. With no change in market share it is estimated this will rise to 390,000 cum by 2014 due to increased building activity. However if timber share in these buildings was increased, the so-called 'potential' scenario, the amount of timber used in the March 2014 year could be as high as 725,000 cubic metres (an increase of about 160% on the current situation).

Figure 2: Gains in timber volumes by building type



NB: Low-rise multi-unit residential are buildings 3 storeys and below. Medium- high-rise are above 3 storeys.

Figure 2 shows the potential gains in market size by building type. The main increase is in medium to low-rise multi-units, and in education and health/ aged care buildings. The "potential" scenario entails a small increase in timber share, both in the main frame, and as the infill frames for external and internal walls and partitions. Note, apartments and low-rise multi-unit residential construction has been included because they traditionally are not large users of timber.

Preferences for various systems for use in commercial sectors

Preferences for structural elements of non-residential buildings are influenced by a large number of factors. Gaston et al.[5] states that many people across a variety of disciplines are involved in materials selection on a construction project. It is therefore often difficult to isolate the rationale for individual material decisions. The nature of design is holistic, non-rational, and strongly influenced by past experience and risk aversion. There is also a widespread association by designers that certain building materials are linked to certain building types, or locations.

The design process is a trade off between thousands of available products and systems taking into account the needs and idiosyncrasies of project site, scale, regulation, performance expectations of the client, and availability of tradespersons. The industry is also highly change resistant and risk averse, and over time, the construction sector has evolved its practices to accept 'standard solutions' for building certain types of buildings, as one material or system gains market dominance. The risks of moving away from established

[5] Gaston et al 2001

practices are high — the standards have emerged for good reason. Market acceptance leads to good rental prospects for the finished building, profit margins are proven for a 'standard' system and there are teams available with the skills and know how to erect to a tight budget and schedule. The construction sector therefore operates strongly on common sense and a well researched slow change mentality. This is not to say there is no willingness to innovate and try new things. If discernible benefits that will improve multiple aspects of a project's success are available through an alternative material system, the industry will certainly be interested in the system. Single issue benefits alone, however, are not enough, as presently used materials are adequate for the requirements of the commercial sector. An example of this is timber's environmental credentials. Few specifiers will switch to timber on environmental issues alone, but add in cost savings or less requirements for foundation strength due to lightweight members, and the system may appear to look attractive as it can deliver a number of merits over presently used systems.

Many material decisions have to do with day to day issues – making things simple and reliable for those designing with and using the system. Specifiers are seeking systems that are:

- Inexpensive (including installation costs)
- Easy to engineer
- Low in regulatory complexity
- Able to be constructed by a skilled workforce
- Of high quality finish
- Of adequate supply and availability, and reliable in delivery time

Currently, wood systems fall short on these features in comparison to steel and concrete offerings for the commercial sector.

Non-residential materials preferences

While no studies were found that indicate specific builder preference for materials in the non-residential sector, a number of sources were found that indicated specific reasons and material/ system attributes which were critical to the material being chosen for a particular project, as follows:

High rise commercial and residential

Concrete still dominates in commercial high-rise and apartment buildings due to total market solutions and franchised systems; and having resolved safety, lifting and handling risks. The ability of concrete to give *proven* noise

and fire separation for not only floor but also inter-party walls, between many small individualised floor areas, combined with the need for less internal finishing and fitout compared to a framed option, benefits the use of concrete in the hotel and apartment sector. Steel options need significantly more fitout to get the required levels of fire rating and acoustics than concrete systems. Concrete supports a low level of detailing so less service routes are needed in apartments and hotels. If thermal mass benefits are utilised using green building principles, concrete structures usually require less HVAC installations.

Smaller construction spaces and non-intrusion into adjacent airspace can mean small cranes are all that can be used on site– this effectively requires lightweight, small size members, and is favouring steel and glass reinforced concrete designs, both of which are inherently prefabricated and modular, and therefore allow less site components and offcuts[6] .

A case study of an 11-storey commercial building built in 2002 at 209 Kingsway, Melbourne showed that versatility and adaptability of structural steel was critical to project success, due to a last minute addition of a 15% increase in floor area[7]. While a steel-framed option was cost-competitive over the original post-tensioned concrete design, the tender was completed in steel due to the potential time-saving.

Over the past decade steel market share in multi-storey construction has declined in Australia (to 7%) cf. UK (70%) and USA (50%)[8]. In Europe, the rise in steel usage in this sector has been dramatic, off a 0% base in 1992, by 2002, 32% of buildings were steel construction, and today approximately 50-60% of 20-30,000 sq m buildings of 15-20m spans are completed in composite steel framing and decking[9]. The majority of this growth is attributed to internationally available novel systems, and the variability in which these systems are utilised. One of the most significant innovations has been service penetrations through beams, allowing lowering of floor-floor heights. Another factor that is attributed to the high growth is where engineers have presented innovative solutions to developers, and tailored the solution to meet the developers' specific needs. A case in point being a Paris project

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[6] New Zealand Concrete, 2000 " Dollars and Sense: The place of concrete in residential towers" pg 23-24

[7] Steel Australia, Dec 2002, "Versatile and adaptable structural steel" pg8

[8] The Warren Centre, 2006 "Steel industry shapes up for greater hi-rise share" e-bulletin # 48 November 2006.

[9] Steel Australia, 2002, "Championing the steel structure" page 24

where steel large open span space was used to demonstrate the commercial benefits of a project building, and the building was rented within 48 hours[10]. The solid demonstration to developers that the building was both buildable and wanted by clients led to multiple builds of this type.

Steel long-span flooring that allows reduction in total weight and number of members means greater usable occupant space; quicker build time and only 2% increase in build cost. Steel decking can act as permanent formwork, and provide tension reinforcement by acting compositely with a concrete structure. During construction this provides a safe working platform, is quick to install, and can act as a lateral restraint to the beam, as well as being a wind-resistant diaphragm. Steel frame is price competitive with concrete for optimised designs, but where steel can have a significant advantage over concrete is delivery times. A steel solution can be delivered up to 30% faster than a concrete solution for the same cost, *provided that a decision for steel is made at the outset of design*[11]. Skill and experience with steel in multi-level structures is still minimal cf. concrete. Costings in steel are also more difficult compared with concrete – with concrete options, quantity surveyors have a higher degree of confidence in costings. There is also a lack of upfront commitment by developers and owners to adopt steel solutions – so some of the key benefits of optimisation and design collaboration with recent exemplar steel projects are not being realised. This combined with the quantity surveyors lack of confidence results in a pervading perception that steel is a higher cost option than concrete. But in contrast, the requirement for higher levels of design documentation in the commercial sector favours steel[12,13]. The best advantages for steel are buildings where grids and layouts suit steel systems. The greatest obstacle to building owners choosing steel is still in the difficulties in handling the fire requirement. Steel members usually require fire protective coatings.

Low rise commercial

The modular nature of steel is attractive – particularly for schools, hospitals, and restaurants – also non-combustibility is an important factor for shops and restaurants. These sectors of the market are very easy for increased light steel frame (LSF) to penetrate. The US has seen rapid growth in LSF in these segments. Builders in low-rise commercial have a greater familiarity in using

[10] Ibid
[11] Ibid
[12] Steel Australia, 2002, "Championing the steel structure" page 24
[13] Beyond 2 website www.stee;.org.au/beyond2/home/default.asp

steel for larger commercial projects, and are therefore more prepared to adopt light steel framing for these smaller projects, rather than timber framing. Steel is ideal for non-standard and complex structures, and due to having less people required onsite to erect the building, cost, safety and construction environment benefits. Steel also gives a dry building option with the use of lost formwork flooring. However, architects find it difficult to express steel aesthetically as exposed structure.

Tilt up concrete panel construction has grown quickly for this market, particularly in the retail sector, as it is very quick to erect and economical, with good thermal mass and acoustic separation. It requires few specialised tools -only needs a cordless rattle-gun onsite – this improves site safety. There is also no waste onsite – less cost from skip bin removal etc.

To be the chosen system in this market segment, the system/ manufacturer needs to:

- Be responsive
- Have excellent detailing
- Have reliable systems infrastructure – capable builders and fabricators
- Have good design documentation
- Have a willingness to see the project through the commissioning stage and correct errors quickly and cost effectively
- The systems needs to be compatible also with the requirements of larger-scale building work, and have sufficient capacity and availability to supply to larger-scale projects – some low-rise projects are expansive and very material intensive.

Major drivers of building practice

The building products industries can aid or inhibit usage and attitudes of users by their infrastructure, assistance and support mechanisms.

Major construction projects are aiming to reduce schedules, improve quality and accuracy and reduce risk. In a number of examples, the close co-operation between designer, contractor and steel fabricator was cited as the reason behind steel's ability to optimise a design to save time and money on a project. For example, in the 209 Kingsway project[14], close liaison between the structural engineers, contractors and steel fabricators and façade contractors

[14] Steel Australia, Dec 2002, "Versatile and adaptable structural steel" pg8

allowed a collaborative approach where steel contractors were integral in the project team from conception. This led to considerable cost savings and erection times, and allowed changes in design to be incorporated smoothly and with limited delay to construction. Occupational health and safety practices are driving offsite manufacturing, and smaller member sizes. Offsite detailing and fixing onsite minimises offcuts and enables a cleaner, safer worksite. The provision of design, supply and erect packages with onsite fixing are very attractive in this sector. A Steel Australia article from December 2002[15] states – "*underpinning domestic steel market growth is strong manufacturing infrastructure, a growing pool of skilled workers, supported by training, coupled by innovation and technology*" (p14). These commercial markets need excellence in design documentation of projects. Steel systems have excelled in gaining trust and reliability by specifiers due to excellence in documentation, and compatibility with current building practices. The timber industry manufacturers and system suppliers need to aid in facilitating good quality documentation. Innovative construction techniques have been employed using steel which allow floor-floor height reduction, improved site safety or reduced construction time.

Steel marketing initiatives

In the UK, concrete holds the lion's share of the non-residential sector: 96.5% of industrial buildings, and 70% of multi-storey[16]. The steel industry is therefore trying to combat this high market share and break into an entrenched concrete mindset. Speed of construction is the main reason cited for the switch from concrete to steel construction systems in the UK and Europe. In Europe, the rise in steel usage in the multi-story sector has been dramatic. Off a 0% base in 1992, by 2002 32% of multi-storey buildings were in steel construction, and today approximately 50-60% of all 20-30,000 square metre buildings of 15-20m spans are completed in composite steel framing and decking[17]. The growth in market share of steel in commercial building sectors within Britain, France (and NZ was cited in the report also) is seen as due to:

- Broader marketing
- Total construction solutions development
- Direct marketing of systems to building owners

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[15] Steel Australia, Dec 2002, "New directions with housing" pg 14.

[16] New Zealand Concrete, 2004 "Concrete fights back – a lesson from the UK" Vol 48 #4 pg 1-2

[17] Steel Australia, 2002, "Championing the steel structure" page 24

- Targeting projects and collaborating with major industry players to win tenders

Over the past decade the market share of steel used in multi-storey construction has declined in Australia (to 7%) cf. UK (70%) and USA (50%). The Australian steel industry has therefore introduced the 'Framing the Future' campaign to try and raise steel market share in the multi-level commercial sector. This campaign identified six issues that contributed to the poor market share of steel in the multi-storey sector compared with international figures:

- Industry leadership
- Value chain effectiveness
- Steel pricing
- International building codes which better facilitated the use of steel
- Technology improvements in the concrete sector
- The need to combat the strengths and highlight the weaknesses of post- and pre-stressed concrete

Advertisements from the Australian FTF and Beyond2 campaigns highlight that their strategy is working. These print advertisements show steel use is on the rise for multi-storey construction: In 2003 7,500 tonnes was used, this rose to 22,500 tonnes in 2004, and in 2005 32,500 tonnes were used. The industry claims in these advertisements that steel used in commercial multi-level building has increased from 3% in 2003 to 13% in 2005.

Quantification of timber use in the Australian non-residential sector

From a survey of 23 low-rise commercial buildings, a model of timber volumes was created and subsequently used to:

- estimate the likely increase in volumes of timber in these markets,
- identify market segments which had the most potential for increase in timber volumes.

Approach

Estimates of timber volumes were based on:

- Building activity volumes
- The relationship between building activity and timber volumes
- The percentage of buildings by type using timber

This data was collected through surveying specifier firms for information about recent building projects, and by visiting specifiers to gain access to building blueprints, and analysing these blueprints to estimate the structural timber use and potential volumes for structural timber.

Building activity volumes

The volumes and values of work by building type were obtained from the Construction Forecasting Council[18] and the Australian Bureau of Statistics. The values were converted to floor areas using Rawlinsons[19], because the ABS data does not include floor areas. The Rawlinsons Handbook of Construction was also used to estimate dollar per square metre rates for each group of buildings. For each group of buildings an 'average' building was chosen to represent that category. With this information estimates were able to be made to calculate square metres of work done per year for each type of building.

Estimating Current Timber Use in the Non-residential Sector

Estimates of timber usage were obtained from surveys of recently completed buildings by requesting data from quantity surveyors and designers and taking measurements off an examination of the building blueprints. Twenty three buildings in Australia were analysed, with data obtained on their type, size, materials, etc. Unfortunately the number of each building in each type was so low that no accurate material transfer ratios were able to be calculated, however the data did show that no buildings had timber as the main frame type. Although this is not the case with all Australian buildings, it leads us to believe that there is a significantly lower proportion of timber non-residential buildings in Australia than New Zealand.

- *Timber transfer ratios*

  The transfer ratios (TRs) are the ratio of timber volume to floor area. New Zealand non-residential building examples were the main data source for calculating transfer ratios and percentages of buildings that are built in timber. This data comes from the BRANZ quarterly survey, and non-residential building plans.

  The New Zealand buildings were used as a base, because of the reliability of data and the proximity to Australia. Australian buildings data was not enough to use solely, so it was used along with the American data to alter the New Zealand transfer ratios to represent Australia.

  Infill and formwork transfer ratios were derived from NZ non-residential building data, with the infill transfer ratios being smaller for industrial and retail buildings because we expect them to use less timber.

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[18] Australian Construction Forecasting Council http://www.cfc.acif.com.au/

[19] Rawlinson's Australian Construction Handbook. Rawlhouse Publishing Propriety, 2006.

The percentage of buildings that were made from timber, steel or concrete were derived from NZ examples, adjusted for Australian factors (using less timber in most non-residential buildings). Data from 2003 from the United States gave transfer ratios for lumber and engineered beam products, which were used to help attain the transfer ratios for the Australian buildings (Table 2):

Table 2: Timber Transfer ratios

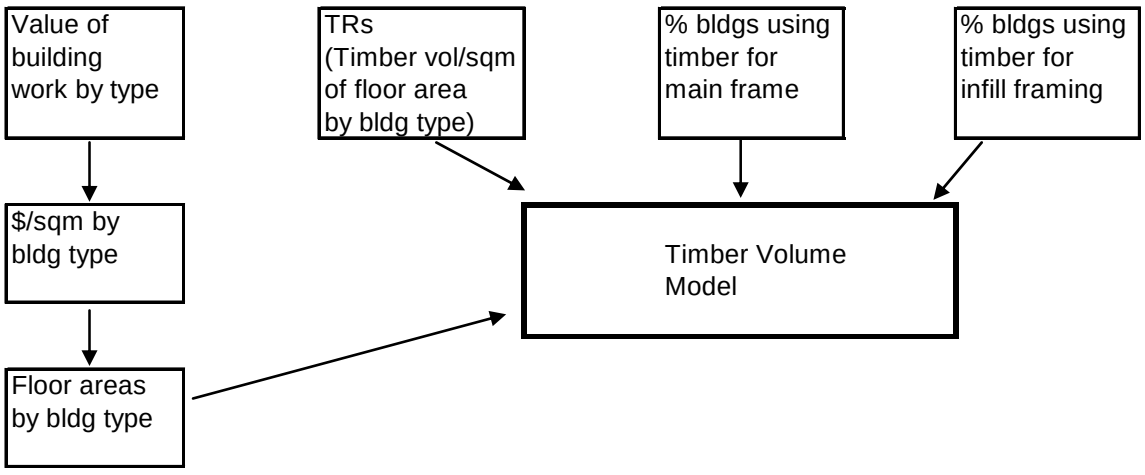
Transfer ratios for timber volumes (Timber lumber & engineered beams volume/ sqm floor area)			
	NZ	USA	Australia
Medium-Rise Apartments	0.14	na	0.10
Retail/Wholesale trade	0.08	0.06	0.07
Offices	0.12	0.12	0.10
Other commercial	0.10	0.14	0.08
Industrial	0.08	0.03	0.06
Educational	0.10	0.13	0.08
Health & aged care	0.12	0.07	0.10
Entertainment & recreation	0.10	0.06	0.08
Accommodation	0.12	0.14	0.10
Miscellaneous	0.10	0.02	0.08
NZ and USA TRs are derived from an analysis of typical buildings. Australia TRs are assumed values based on NZ and USA TRs.			

Estimating potential timber volume use

Market share percentages for timber used in non-residential buildings and apartments in Australia were assumed from the surveys of recent building designs, and also known timber market shares in New Zealand and North America.

A timber volume model (Figure 3) was created using the data gathered to estimate likely current and future structural timber usage for various building types.

Figure 3 Timber volumes model



Results

The surveys of twenty three recently completed buildings found very little timber used in any of the different non-residential building types examined. Concrete was the predominate main frame material, with some steel framing. No timber main frames were found though there was some timber roof framing (5 buildings). The infill framing and partitions were almost all steel frames or concrete masonry/ panel infills, though 3 of the buildings had some timber partition framing.

The last column in the Appendix table (*refer appendices*) records opinion on the potential to substitute. In most cases the respondent (mainly quantity surveyors) found it difficult to judge if the main frame could be replaced by timber, and hence they made little comment. What comments were made suggest partition walls, and in one case, the roof, are the components seen as a possibility for substitution.

The market share percentages assumed are shown in Table . We could not find much research to back up these percentages, but our limited survey suggests low percentages for timber.

Table 3 Timber market share assumptions

Non-residential buildings Current and potential timber usage				
Type of building (1)	**% Timber frame**		**% Timber Infill**	
	Current	Potential	Current	Potential
Med-High Rise Apartments	0	0	5	10
Low-rise multi-units	5	15	10	20
Retail/Wholesale trade	3	10	10	20
Offices	3	10	10	20
Other commercial	5	5	5	10
Industrial	3	5	5	10
Educational	10	25	10	20
Health & aged care	5	15	5	10
Entertainment & recreation	10	20	10	20
Accommodation	15	25	10	20
Miscellaneous	3	5	5	10
Total				
(1) Australian Bureau of Statistics categories.				

The current estimated market size for sawn timber in non-residential buildings is shown in Table below (thousands of cubic metres used), by type of building, going from 2003 to 2014 (years ending March). Note that the data from 2008 onwards is based on building activity estimates, whereas earlier building activity data is as

recorded by the Australian Bureau of Statistics. This table shows future volumes at the current estimated market share for timber.

Table 4 sawn timber volumes with current market shares

Non-residential buildings Cubic Meters (000) of Timber used by building type per year Current timber market share												
Type of building (1)						*Estimate* →						
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Med-High Rise Apartments	23	25	25	23	21	23	25	27	29	32	34	35
Low-rise multi-units	54	58	58	52	48	52	58	62	67	74	78	82
Retail/Wholesale trade	21	21	23	27	26	28	27	28	29	30	32	32
Offices	31	36	35	40	47	52	49	47	47	48	50	53
Other commercial	6	6	7	7	8	7	7	7	8	8	8	9
Industrial	16	17	19	22	23	22	22	22	23	24	25	26
Educational	31	33	32	38	39	42	44	47	48	50	53	56
Health and aged care	13	13	12	12	15	16	17	18	19	19	20	21
Entertainment and recreation	24	20	20	22	23	24	24	24	25	26	28	29
Accommodation	15	16	18	21	19	20	23	25	27	28	30	32
Miscellaneous	7	7	9	11	14	12	11	11	11	12	13	13
Total	**241**	**251**	**258**	**274**	**283**	**298**	**307**	**318**	**333**	**352**	**372**	**390**
(1) Australian Bureau of Statistics categories.												

When gains in market penetration are assumed the volumes of timber are significantly increased, as shown in Table . This is the "potential" scenario and the biggest gains for timber framing are in medium rise apartments, educational and aged care buildings. All other buildings are expected to increase at least slightly. The volumes include timber infill which is the framing between the main structural frame, and includes partitions. We expect timber use for infill/ partitions to increase by about 5% to 10% for most building types.

Table 5 Sawn timber volumes with increased market penetration

Non-residential buildings Cubic Meters (000) of Timber used by building type per year Increased timber market share												
Type of building (1)						*Estimate* →						
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Med-High Rise Apartments	23	25	25	23	21	25	29	34	38	42	46	51
Low-rise multi-units	54	58	58	52	48	63	79	95	110	126	142	157
Retail/Wholesale trade	21	21	23	27	26	32	38	45	51	57	63	69
Offices	31	36	35	40	47	55	63	70	78	85	93	100
Other commercial	6	6	7	7	8	8	9	10	10	11	11	12
Industrial	16	17	19	22	23	26	29	32	35	38	41	44
Educational	31	33	32	38	39	51	62	74	86	97	109	121
Health and aged care	13	13	12	12	15	19	23	27	31	36	40	44
Entertainment and recreation	24	20	20	22	23	27	32	36	40	44	48	52
Accommodation	15	16	18	21	19	24	29	34	38	43	48	53
Miscellaneous	7	7	9	11	14	15	16	17	19	20	21	22
Total	**241**	**251**	**258**	**274**	**283**	**346**	**409**	**473**	**536**	**599**	**628**	**725**
(1) Australian Bureau of Statistics categories.												

The assumptions made in the 'potential' scenario are BRANZ's best estimate at what could be possible given the current situation in Australia. The percentage of buildings (concrete and steel) that used timber infill was also derived from NZ examples, but again they were reduced to reflect that Australian buildings use less timber.

Some of the above assumptions that were made were a 'best guess' made by BRANZ, and with further consultation with industry experts (especially in Australia) these assumptions might change.

The table assumes the market penetration gradually rises until it achieves its full amount in 2014. Hence the volumes would increase from 283,000 cubic metres of timber for the March 2007 year to 346,000 cubic metres of timber for the March 2008 year, this number would then increase up to 725,000 cubic metres of timber for the March 2014 year.

The timber volumes above are for the main structure (walls and floor beams), the roof frame (trusses and rafters), and the non-load bearing partitions. These categories are shown separately in Table and

Table . Timber floor volumes are also shown, for structural flooring, and not overlay.

Table 6 Partition walls and timber floors with current market share

Non-residential buildings - Timber partition walls and timber floors **Current timber market share**												
						Estimate →						
Timber component	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
						000 cubic metres						
Structural framing	117	120	124	135	141	147	154	161	168	175	182	189
Roof framing	17	17	18	19	19	20	21	22	24	25	26	27
Wall partitions (non-load bearing)	55	58	59	62	63	67	71	75	79	82	86	90
Formwork (concrete)	53	56	57	59	61	64	67	71	74	77	81	84
Particleboard flooring	7	8	8	8	9	9	10	10	11	11	12	12
Sheet plywood flooring	12	13	13	15	15	16	17	17	18	19	19	20

Table 7 Partition walls and timber floors with increased market penetration

Non-residential buildings - Timber partition walls and timber floors **Increased timber market share**												
						Estimate →						
Timber component	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
						000 cubic metres						
Structural framing	117	120	124	135	141	178	215	252	289	327	364	401
Roof framing	17	17	18	19	19	23	28	32	36	40	44	49
Wall partitions (non-load bearing)	55	58	59	62	63	82	101	120	139	159	178	197
Formwork (concrete)	53	56	57	59	61	63	66	68	71	73	76	78
Particleboard flooring	7	8	8	8	9	12	15	18	21	25	28	31
Sheet plywood flooring	12	13	13	15	15	20	25	29	34	39	43	48

The total potential size for timber capture by 2013 is estimated to be growth of 160%, or 331,000 cubic meters, and this is predominantly from infill/ partition framing. The potential for increase in timber use for various non-traditional market sectors is shown in Table 8:

Table 8: potential growth by market sector

Sector	**Current 2007 volume (000 cum)**	**2014 modelled volume with current usage (000 cum)**	**2014 modelled volume with increased market penetration**	**Potential increase from effort to increase market**

			(000 cum)	penetration (000 cum)
High rise residential	**69**	**117**	**208**	**91**
Med-High rise apartments	21	35	51	16
Low rise apartments	48	82	157	75
High rise commercial	**74**	**94**	**165**	**71**
Offices	47	53	100	47
Other Commercial	27	41	65	24
Low rise commercial	**103**	**138**	**286**	**125**
Retail	26	32	69	37
Educational	39	56	121	65
Entertainment	23	29	52	
Health and aged care	15	21	44	23
Other	**37**	**39**	**66**	**27**

Discussion

Volumes of timber used in non-residential buildings have been estimated with the models described above. We could not find data to check the current volumes, so we have been unable to "calibrate" our model to what is actually being used in non-residential buildings now. Hence the timber volumes need to be used with caution.

The surveys of quantity surveyors and designers suggest the timber use is low, and in comparison with New Zealand the current timber volume in non-residential buildings is about the same, despite much larger volumes of work in Australia. New Zealand market share is at least a third higher and for some building types (education, entertainment, and accommodation) is more than double the percentages used for Australia. Australian research[20] suggests designers are receptive to the use of timber, provided support (design, documentation and information support) for timber designers is increased.

The partitions market is a significant size and we have assumed some market share gains here, see Table . A cost study of the various partition systems is suggested, to determine if the projected market gains are feasible in this segment. Given these findings the increases postulated in Table are believed to be challenging, but realistic, as a first approximation. It is not unreasonable to expect a significant increase in timber market share in new non-residential (and multi-unit housing) projects. It is not part of this report to set these targets, but as a starting point for discussion on the most promising market segments. The models developed also enable the market size to be calculated for various assumptions of market share.

[20] Nolan et al (2000) "Factors that influence design professionals when they use structural timber in Australia.: NZ Timber Design Journal Issue 4, Vol 9.

New Applications of Timber Systems

From the literature and quantification study, there appeared several market segments that showed promising potential volume growth in terms of medium to longterm building activity, and ability for timber to expand into the markets. These included:

- Low -rise retail
- Low-rise resorts
- Low-rise health care/ aged care/ stand alone clinics
- Public libraries and educational facilities
- Med-rise offices and high-rise apartments (fit out)

Workshop

The major attractiveness of materials and systems presently used in the non-residential and apartment sectors was presented alongside the quantification models to a small group of industry representatives in Sydney during September 2007. The workshop was structured to outline the most promising applications that had arisen from this stage of the research, gain feedback from participants on the likely market potential of these applications, and also investigate ways that these applications might be used in the Australian low-rise market context. Using the promising market segments to brainstorm possible novel timber applications (applications which were commonly used overseas but not in Australia, or that were new to market or had been launched in the past but failed at that time) six applications emerged from the workshop discussion as the most promising, and two were reviewed in further detail:

- Flooring cassettes (prefabricated flooring modules)
- Prefabricated building modules (rooms or small stand alone units)
- Timber tilt-slab panels (solid panel construction)
- Aesthetic overlays (veneer-covered large members)
- Multi-storey fitout (including an alternative to Rondo-type infill framing systems, ducted skirtings, and cabinetry as a partition wall cabinetry)
- Access flooring (raised plenum instead of ceiling space to provide flexible cabling and ducting)

Promising Applications

The two most promising applications (Cassette flooring modules; and Access Floors) have been briefly scoped using a literature review and internet based

search to give the industry on overview of the concept, as well as outline issues and considerations within an Australian market context, and recommend a pathway forward for the Australian timber industry to progress the concept. These two applications were identified at the industry workshop as being the most promising applications by which timber systems might enter the Australian non-residential and commercial sectors. An industry steering group requested further information relating to what might be required by the timber sector in order for firms to expand into these markets. A short scoping report outlining the concept and the business proposition has been written for each of these systems (*refer appendices*) but the reports are not standalone business plans or marketing strategies. Recommendations for furthering market entry of these systems into the Australian commercial building arena have been given, including overcoming some identified barriers to market entry. These have been provided to aid individual firms in the development of formal business cases, should they wish to take up these opportunities.

APPENDICES

ACCESS FLOORING

A short scoping report outlining the concept and the business for Access Flooring follows. This report is not a standalone business plan or marketing strategy. Recommendations for furthering market entry of these systems into the Australian commercial building arena have been given, including overcoming some identified barriers to market entry. These have been provided to aid individual firms in the development of formal business cases, should they wish to take up these opportunities.

Concept

Access floors contain a system that delivers heating, ventilation and air conditioning (HVAC), electrical power, cabling, and other utility services underneath an accessible, flexible modular floor, that is load bearing but a non-structural infill. The floor consists of a series of panels that are held at the corners by steel or polymer moulded pedestals. The pedestals are attached to the main structural base by adhesive, and the panels are screwed or clipped into these pedestals for easy access and removal. The panels often have cut-outs and plastic fittings where wires can be accessed, or grills are placed.

Access floors have traditionally tended to be used mostly in IT facilities, in control rooms for high-tech equipment and laboratories, in rooms with limited human access. These rooms have much cabling, and heavy equipment point loads. The access flooring system is able to distribute these loads evenly across the floor, while giving laminar air flow ventilation and easy access to wiring for re-routing of systems and repairs. Increasingly, office space is turning to these systems due to an increase in wired services and computer/ electronic office equipment, open plan cubicle set-ups and high turnover of tenancies. Therefore access flooring is becoming a smartly used system to deal with increased cabling requirements:

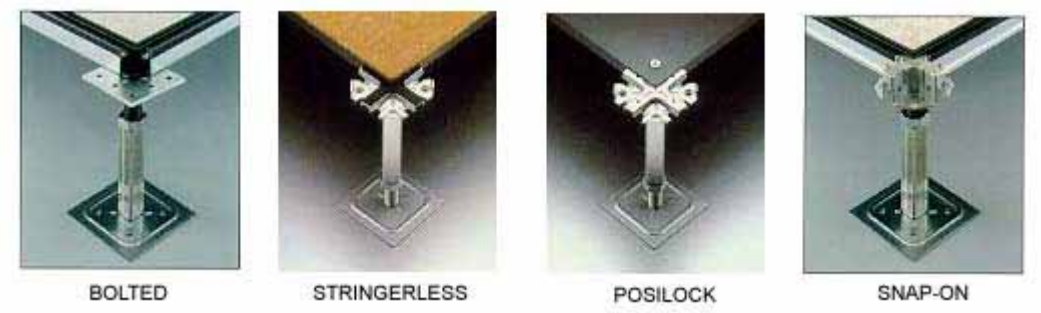
"No longer can we have one plug at our desk, we need a strip...make that two strips. With a minimum requirement of a personal computer at a desk, the wires in an office quickly became unmanageable and uncontrollable." – AcessFloors website.

General office access floors are usually made from wood core or steel materials, as they are lighter weight and less expensive than other access flooring solutions. They do, however, need high tolerances regarding even height due to the higher visual quality of the office environment. Unlike control room or equipment room systems, most of the general office systems or overlaid with prefabricated floor coverings, or carpeting.

Product features and benefits:

The system is made up of four main components:

- Understructure: Typically galvanised or powder coated pedestals with or without stringers. The pedestal systems are typically subject to design patents. The understructure may also contain PVC or other plastic components. A feature of the Tasman Access Floors system is the absence of any PVC parts on grounds of environmental sensitivity.



- Panels: These panels are engineering to meet a range of loadings and where necessary, anti-static and anti-particulate requirements. The range of materials used include:
    - Steel cases in-filled with light weight cement compound
    - Steel cased wood core (particleboard)
    - Steel cased calcium sulphate
    - High density particleboard with top & bottom steel sheets
    - Aluminium (special clean room applications)
    - Hollow steel (special clean room applications)
    - Glass (special decorative applications)
    - Plywood (special residential applications)
- Floor finishes: These can be site or factory applied and include: carpet, ceramics, marble/granite, timber, vinyl and high pressure laminates.
- Accessories: These include various styles of grommets for wiring, grills for air diffusion and service boxes. Also includes a range of panel removal handles for lifting the panels.

There are three main benefits of the system:

1. The ability to use the cavity as a plenum for air supply and remove the ductwork typically hidden in the ceiling plenum. This is referred to as Under Floor Air Distribution (UFAD). It is a favourite strategy in green building circles because of claims that it can provide better occupant comfort with reduced energy costs and increased air quality, while

allowing for easy maintenance and flexible use of space. In North America, Access flooring is undergoing resurgence due to these green building claims.

2. The ability to configure the service routes easily over time, to have services supplied at any point where they are needed, rather than to have built in cabling services emerging at a fixed location in the wall or floor.
3. The cost benefits of having leased fitout over built-in fitout from both a developer and an occupier perspective

The benefits to the building owner / developer are in:

- reduced floor to floor height as the air conditioning services are contained within the floor allowing the removal/reduction of the suspended ceiling.
- the ability to erect a structure with cabling requirements not fixed to the structure.
- the ability to erect a structure with minimal cabling requirements.
- the ability to adapt and renovate the structure and partitions and infill without compromising the delivery of services.
- incomparable first-build and long-term value and flexibility due to unlimited ability to reconfigure data and electrical systems on demand.
- reduced energy costs, improved indoor air quality, and enhanced personal productivity and comfort.
- The ability to market the office space as an environmentally-conscious construction solution.
- Increased acoustic performance of the floor systems.

Benefits to building occupiers include:

- an easily accessible cabling route, delivered to the electronic or data medium using a controlled and manageable cabling system
- room for cabling expansion over time
- the ability to undertake maintenance simply, and with no repair costs to the structure and fitout.
- Control over the fitout look, style and configuration from leased fitout.

Disadvantages

- All floors in the level need to be raised otherwise steps will need to be introduced.

- Access floors need to be a part of the building planed from day one. The lifts need to be design to account for raised floor, and services need to be designed for use in the floor plenum rather than the ceiling plenum.
- Common areas of buildings such as toilet amenities need also to be raised.
- Leaks may cause damage to under floor services.

Examples of overseas systems in use

Access flooring is used in a wide range of applications where the underfloor space is used to reticulate data and electrical services and/or provide fresh or conditioned air distribution. These applications include:

- General office/commercial areas
- Office/commercial corridors and lobbies
- Plant and equipment rooms
- Computer and data storage rooms
- Call centres
- Educational facilities
- Research facilities
- Hospitals
- Restaurants/Kitchens
- Banks
- Control rooms
- Dealing/trading rooms
- Casino/gaming rooms
- Residential interiors (less common)

The biggest markets are in locations where major skyscraper developments are occurring (eg UAE, Shanghai). There are a large number of Chinese producers (including Jindao, Xinghang, Hua Tong). These companies can produce millions of square metres of product per year.

Existing systems used in Australia for low-rise upper level floor systems

There are three main suppliers/ manufacturers in Australia:

- Tasman Access Floors (Fletcher Building), who claim to be the sole manufacturer of raised access floors in Australia, with over 1.2 million square metres of installed base. Tasman Access Floors have manufactured, supplied and installed a wide variety of Access floors systems for commercial and domestic buildings in Australia for over 20 years. The need for large column free space necessitated the use of raised access floors. were the preferred raised access floors specialists for approximately 22,000m2 at 126 Phillip Street, Sydney. Tasman also

installed access flooring at 30 The Bond. Both of these buildings are commercial office complexes designed to meet 5-star rating. Installers of this system are Comprador: http://www.comprador.com.au/af-solidfeel.php

Tasman already supplies a timber access floor product into the Australian market, branded as *Woodcore*™. This is a high density particle board with hard wearing high pressure laminate that provides durability and acoustic rating. To increase strength, the bottom surface is bonded with a layer of hot dipped galvanised steel.

Tasman Access Floors Pty Limited
28 Biloela Street, VILLAWOOD NSW 2163
Ph : 61 2 9728 4111
Fax: 61 2 9728 3088
Mob: 0413 232 080
g.lee@tasmanfloors.com.au (Gavin Lee)

- ASP Access Floors, begun in July 2000 to offset the Tasman monopoly in the Australian market place. ASP have sales offices in Sydney, Perth and Auckland, as well as Dubai. Their website claims a volume in excess of 6 million panels produced since 2000, and that they are now one of the largest suppliers in the Asia Pacific region. A detailed explanatory product guide is available at http://l.b5z.net/i/u/6077880/i/ASP_Product_Guide.pdf

ASP Access Floors
32 Prime Dr
Seven Hills, NSW, 2147
Sydney Australia
Tel: + 612 9620 9915
Email: enquiries@aspfloors.com.au

- Meridian Cable Management who supply the Hewetson access floor system from the UK.

Likely competitiveness of the system

Market size

The potential floor area for med-high rise apartments and office buildings is estimated at 6,825,000sq m (ref):

- 3,107,000 sq metres for apartments
- 3,718,000 sq metres for offices

The project sizes for access flooring can be very large. A list of projects by Tasman Access Floors using carpet tile systems includes many banks, head office buildings and Government departments, ranging from 800m2 to over 25,000m2.

Costs

Detailed manufacturing costs are held closely guarded by manufacturers, and are dependent on the configuration of the flooring system.
Access Floors quote a range of $US14-25 /sqft, plus $US5/sqft for installation costs. The Rawlinsons Construction Handbook quotes $AU110 -$AU250 installed cost per square metre, with additional costs for air grilles, laminate finish and vinyl and carpet overlays.

Strengths

- Construction programmes are reduced by at least two weeks per floor due to elimination of a sand cement screed.
- As warm air rises, considerable cost savings are achieved by an underfloor air plenum delivering conditioned air exactly where it is needed - compared with the traditional uneconomic alternative of forcing conditioned air from the ceiling.
- Maximum flexibility for the installation and reconfiguring of services to equipment and workstations a matter of hours.
- In new construction the use of an access floor for total service distribution reduces the overall building height by about 13%. Or, for the same height, you can increase the number of floors. (Kingspan in UK)
- Reduces/replaces suspended/hanging ceiling systems (including related scaffolding)
- Saves air con ducting costs
- Reduces cost for rough-in of plumbing and electrical services
- Involves less pre-planning and construction to accommodate services because services have no impact on the structure – therefore suits developer and project manager
- Reduces dismantling costs (hence no demolition costs at the end of tenancy)
- Reduces material costs as the system is reusability at end of lease and can be used on other tenancies
- Potential for surface finish (skins) and floor panel in one unit

Weaknesses

- The whole building level requires this system to be installed. This needs to be planned at the construction stage.
- The system requires a major change in thinking and design practice in terms of standard Australian commercial floor and service fitout.
- How are changes in floor height handled?
  - must it be allowed for in the floor to ceiling height of the building or can it simply be something that is dealt with via lift settings
  - what happens where the access floor meets wet areas or non-access floor areas

Business proposition

- The need for flexible commercial fitout, and an increasing requirement to provide high-quality air controlled, open space office environments is opening up the market for access flooring in Australia.
- These systems are used extensively internationally, and two main suppliers already exist in the Australian marketplace – ASP and Tasman.
- The systems that are on offer include a woodcore panel. Tasman Access Floors (through Fletcher Building) therefore already supply Australasian based timber products into this market.
- The most promising extensions in Australia include expansion of use of access flooring in general office environments, as an alternative to ducted skirtings and conduit systems, or wiring data and voice cabling systems through the wall.
- There is a major opportunity to link such an initiative with timber hardwood flooring initiatives for the surface finish, as another opportunity to gain market entry for unique Australian hardwood flooring systems. This is a potential point of difference over existing imported systems, and allows an outlet for Australian timber suppliers in this market space over and above particleboard or plywood products supply.
- Due to the presence of existing market entrants in Australia, and the high quality control and precision of manufacturing the panel products, the business opportunities in this market appear 3-fold. Competing head to head with these producers (although ASP have done so successfully against Tasman) would appear a less favourable option than working alongside these businesses to enhance their product range through an increased volume of timber. The partnering opportunities appear to be:

- Work with ASP and Tasman to increase the use of woodcore based panel systems over predominantly cementious or steel-based panels
- Partner to provide a veneer or laminate flooring finish (similar to that provided by the high pressure laminate or carpet tile finish) in Australian hardwoods.
- Extend the product range to include a hardwood panel system for high-rise apartment fitout (where a timber-based flooring system may not require the loading performance properties of the steel and concrete core systems), utilising plywood and veneer overlay. This may be similar to laminate strip flooring (except larger removable panels), or simulate the Matura infill flooring system ( ) from the Netherlands.

Suggested pathway forward

To achieve this will involve three core activities:

- The first opportunity here is to extend the amount of particleboard used in Access flooring applications in Australia at the expense of steel and cementious product. To advance the opportunity, discussions would need to occur with suppliers of access flooring (eg Fletcher Building, ASP Access Flooring) about the potential to increase the wood-based panels side of their business. As Fletcher Building is a vertically integrated building products manufacturer with their own wood panel manufacturing capability, there may be limited scope for a wider industry approach. However, there may be an opportunity to develop an advanced woodcore material that can meet the higher performance specifications that cementious or steel panel materials are currently used for. There is an opportunity to establish the performance criteria for non-wood access flooring panels, and to undertake a product development project to meet these requirements with a wood-based panel system. One option is to encourage franchise or marketing co-op approach. Under this scenario, the binding feature of the co-op could be that all producers use Australian Particleboard/Ply/Hardwood panels. This would free up the ability to use pedestals etc from Jindao, Tasman or others.
- The second opportunity would be to work with manufacturers of access flooring both nationally and internationally, to expand the use of Australian hardwood products as the surface finishing material. Timber companies would offer hardwood overlay materials (or finished panel floor coverings) to be utilised in the access flooring range. This is a low-volume, high value proposition, and a potential

outlet for Australian hardwoods to be used in a new market environment.

- A third opportunity would be to develop plywood-based systems with Australian hardwood overlay for niche residential applications (especially concrete apartment fit-out). Of the three, this is the most innovative product development opportunity as access flooring is not commonly used in residential applications and plywood is an uncommon material used for panels.

Critical success factors

1. Performance issues for the system include freedom from vibration, sound transmission, electrical resistance and fire rating. For green and high-performance sustainable buildings, the avoidance of toxic materials that could reduce indoor air quality is important (including sealers, varnishes, formaldehyde resins and off gassing), as is the avoidance of building and construction waste and the ability for the system to be reused and/or the parts recycled.

2. Panel systems that are gravity loaded are subject to movements of the structural flooring, as the building settles. This can cause the access flooring to shear or bow as the flooring under structure becomes more uneven. Additionally, sunlight hitting the flooring can cause thermal expansion of the panels. ASP systems claim to have overcome these issues through use of expansion systems in the pedestals (patented system).

3. With so many manufacturing suppliers out of China, the Australian industry will need to ensure a cost effective solution, and that good supply deals are in place with installers. Cost and quality will be key, otherwise these systems will simply be imported from China and the US. Key benefits of Australasian woodcore panel over Asian product are: a) core wood from sustainably managed forests; b) lower formaldehyde boards produced; c) quality of particleboard and laminates and also d) ability to supply Australian native hardwoods as a surface finish material. To overcome the risk of Asian or European imports, a strong Australian branding with an ecolabel is needed – the industry needs to stress to installation operators and building owners the importance of choosing low emitting but biological (renewable) materials, and the environmental benefits of these systems over cheaper, less environmentally-sound imported systems.

4. Manufacturing of laminate flooring and finished panels requires precision finishing equipment, as there needs to be low difference between panel thickness, and uniform finishing quality, to give a high quality flooring surface. This machinery is expensive to purchase, and it would therefore be better to manufacture Australian hardwood overlay finished panels as part of an existing Australian timber flooring outfit manufacturing other product off these lines, or else supply veneers or thin strip timber materials to the access flooring manufacturing sites, to manufacture these as part of their own product range.

5. Tasman Access Floors and ASP Floors have developed a good reputation in the commercial access flooring market. Any product development initiatives or new product offerings will need technical support from the timber industry, and funded R&D programmes to ensure issues are smoothed out prior to market entry.

Information resources:

Access Floor Systems Inc. : www.accessfloorsystems.com/sys/?access=/selector/general.html

Tate ASP Access Floors : www.aspmaxcess.com

The Access Flooring Company: http://www.accessflooring.com

Access Floor Systems: http://www.accessfloorsystems.com/access

Cemac Interiors:
http://www.cemacinteriors.co.nz/index.cfm/Products/Computer_Floors/Fibrecore.html

ASP Australia : http://www.aspfloors.com.au/home

Tasman Access Floors: http://www.tasmanaccessfloors.com.au/tasman.htm

Computer Site Solutions: http://www.computersite.com.au/raisedfloors.html

"Corporate Headquarters teems with ideas" :
http://www.smalesfarm.co.nz/index.cfm/news/articles/corporate_headquarters_teems_with_ideas.html

CASSETTE FLOORS

A short scoping report outlining the concept and the business for Cassette Floors follows. This report is not a standalone business plan or marketing strategy. Recommendations for furthering market entry of these systems into the Australian commercial building arena have been given, including overcoming some identified barriers to market entry. These have been provided to aid individual firms in the development of formal business cases, should they wish to take up these opportunities.

Concept

Cassette Flooring consists of prefabricated light weight timber flooring modules for upper-storey flooring of low-rise (1-3 storey) buildings. These cassettes are completely pre-manufactured large floor slabs that can be craned into position, and incorporate all joists, blockings, insulation, service route holes and pre-fixed weatherproof deckings. The modules are constructed to high tolerances, and engineered to ensure structural performance needs, using automated systems and CAD design packages. The modules consist of joists and the top flooring substructure, and are either left open, or are encased into a box-frame with a thin wood panel ceiling (OSB or plywood). Enclosed frame panels can also include insulation, ducts or service route apertures, and cabling. The panels are craned into place in the building once the lower storey walls are in place, and usually platform construction techniques are employed (the floor panel sits on the top of the bottom storey frames).

Three generic timber flooring cassette types are used in practice:

1. Engineered wood product joists (often standard I beams, or flange and web systems) with wood-panel top (i.e. OSB, particleboard or plywood). Usually these are double skin to construct a box section and to maintain alignment of joist or panel during transportation and erection.
2. Trussed lattice beams replacing I-joist systems, with a wood-panel type upper surface and open lower ceiling space.
3. Composite concrete-wood floors where the top surface is covered with a layer (35-50mm) of concrete, which has been either cast offsite, or is poured after all the cassettes are installed. Long-standing practice in the USA is to pour lightweight concrete over a conventional wood floor to achieve improved acoustic performance.

Modern Methods of Construction (MMC)

The UK is presently facing a serious housing shortage, with the number of households increasing from the present 175,000 per annum, to an estimated 230,000 per annum by 2016. This is the main driver for a building systems practice dubbed 'Modern Methods of Construction' (MMC). Other key drivers include the need for sustainability in building practice, the need for increase in thermal and sound performance, and a shortage of skilled labour. MMC consists of offsite manufacture of panels and volumetric modules. The main benefits from MMC are in resource efficiency, speed of construction, high standards of design quality, improvement in onsite safety and overcoming skill shortages due to reduced labour requirements onsite.

In England, a few large private housebuilders have recently invested in factories that produce prefabricated housing panels (around 30 house building factories exist), and an estimated 5% of housing is built using prefabricated panel construction. In Japan, it is estimated 40% of new housing uses MMC (much is volumetric modular) and there is increasing use of these systems in Scandinavia and Germany. The reasons why other European nations are investing in the method are believed to be due to a short building season due to cold climates, the reduced disruption to neighbouring buildings and earlier occupancy, and cultural preference for timber buildings.

Industry sources in the UK indicate that the MMC method of construction for low-rise buildings costs an additional 7-10%, but allows up to 50% reduction of construction time on site, thus reducing labour costs. The industry claims that houses manufactured and erected using prefabricated systems can be erected in just a few days (5 days with a 3 man team and a crane), thus removing risks from delays due to bad weather. This reduces build time by up to 4 weeks on average, over conventional timber-frame construction. This is comparable to the claims of the steel prefabrication systems, such as Corus, who claim can be finished within 5 working days (not including siteworks and foundations).

Examples of overseas systems in use

Europe appears to have offsite construction techniques, including cassette floors, well established as a building practice. The UK is by far the leading nation in this initiative, with at least four large scale operators supplying the market. In contrast, North America does not seem to have adopted the flooring cassette technology, although there is evidence of panelised systems and volumetric modules, particularly in the low-cost housing markets. With the exception of pre-manufactured roof trusses, which are nearly always used

in residential building starts, North American usage of prefabricated panels is quite low and growing slowly at best. Floor panels are lagging behind wall panels in terms of adoption by manufacturers and builders, and even wall panels are slow to uptake. Prefabricated floor panels are therefore not yet widely used but ripe for development in this market.

A sample of European systems available include:

Finnframe – A Finnish system supplying the UK market. This consists of an insulated box construction using I beams with OSB webs:

Extract ©Finnforest UK Ltd.

Contact: Finnforest UK Ltd., The Heights, 59/65 Lowlands Road, Harrow-on-the-Hill, Middlesex HA1 3AE, UK. Tel. +44 (0)20 8420 0777 Fax. +44 (0)20 8422 9368

Gitterbjelke – Made in Norway, a special purpose lattice beam flooring system of parallel chord floor trusses, custom designed for each project. The flooring surface is constructed of solid timber planks, rather than reconstituted woodfibre panel or ply. The open web truss structure allows services to be routed through the lattice structure without compromising structural integrity with service penetrations of the web, and can take additional loads over conventional I-joist flooring systems, while having built-in service penetrations.

Contact details: Anders Homb or Arnold Sagen, c/- Norges Byggskole, Byggforsk, Bjørnsonsgate 33, Postboks 293, 2001, Lillestrøm. Tel 47 63 89 25 60 Fax 47 63 80 35 00 www.takstol.com

Advanced Panel Systems (APS) – Cornwall-based manufacturers of prefabricated timber flooring slabs with factory fitted thermal and acoustic insulation. Precision CAD and automated CNC machining of panels uses predrilled holes to match precisely with the service routes of adjoining panels.

Company contact details: Advanced Panel Systems (UK) Ltd, Pohilsa, Stoke Climsland, Callington, Cornwall PL178PP. UK. Tel 01579 370740. info@advancedpanelsystems.co.uk

Prestoplan – Prestoplan use an open metal web with timber flange joist system, with a timber flooring panel. The use of a thin metallic web makes it suitable for applications where extensive services and in particular, large ducting is required.

Company contact details: Prestoplan, Four Oaks Road, Walton Summit Centre, Preston PR5 8AP, UK. Tel 01772 627 373 www.prestoplan.co.uk

Two large housing suppliers using offsite construction and flooring cassettes include Stewart Milne (www.stewartmilne.com)and Kingspan (www.kingspan**offsite**.com).

Existing systems used in Australia for low-rise upper level floor systems

A variety or options exist for suspended flooring in low-rise applications. These include:

- Engineered timber floors (e.g. site constructed floors using I-beams, LVL)
- Light weight steel framing (analogous to the engineered timber floor)
- Insitu formed reinforced concrete slabs
- Fully precast reinforced concrete floors
- Concrete floors using permanent steel deck formwork (e.g. Bondek, Condeck, Conform)
- Precast concrete flooring systems based on hollow core planks (e.g. Hollow-core, Quickfloor, Deltacore), permanent formwork systems (e.g. Humeslab, Transfloor) or prestressed beams with infill panels (e.g. Resdek, Ultrafloor)
- Autoclaved aerated concrete floor panels (e.g. CSR Hebel)

Each of the above systems has certain advantages over traditional concrete pour in situ formwork slabs: Reinforcing through the use of steel rods and grid systems; permanent formwork which creates a deck platform to continue working from; lighter weight systems such as AAC and hollowcore concrete systems, and timber and steel systems; and precast systems that are produced offsite and crane lifted into place. Timber flooring cassettes compare to precast options, as well as being a lighter-weight solution. They also offer an immediate permanent structural decking level with which to continue

building from. Concrete flooring systems are very cheap on a per weight basis, however, the lightweight nature of timber makes the timber option cost competitive. The price of concrete is about 5 times the price of glulam in terms of $/cubic metre but the price of sawn timber is only about twice that of concrete. Substituing a solid glulam slab for a concrete slab would be 5 times the cost. However, the cost comparison of concrete and timber floor systems of equivalent structural performance will see timber be only about 1.5 times the cost of concrete.

Competitive performance of timber flooring cassettes compared to these existing systems centre around two main aspects:

1) The advantages/ disadvantages of timber frame construction versus steel and concrete building systems. These usually involve the lightweight strength to weight ratio for timber, the requirement for concrete formwork over a dry process, the level of innovation and system sophistication and precision, builder knowledge and skill in working with the systems, and timber code restrictions for certain building types. In the main, these are the same issues which have been addressed in Australia through the MRTFC programme.

2) The advantages/ disadvantages of prefabricated systems over traditional site-based construction techniques. Here, the main drivers are:

- Speeding up the time of erection (thereby reducing cost)
- Reducing waste produced at the site
- Increasing the use of assemblers over trades (thereby reducing cost)
- Improving safety (through transferring part of the construction to a more controlled factory environment)
- Reducing the overall quantity of materials used (thereby reducing cost)
- Achieving economies of scale through repetitious factory production (cost)

Cost and performance issues

Offsite construction of flooring cassettes requires an increased level of precision and automation over traditional engineered wood product component manufacture. In large UK operations, entire building plans are fed into the automated manufacturing process for a 'whole building' design approach to the floor component manufacture. This level of detailing and holistic design thinking requires excellence in construction project management at the shop-floor level. UK offsite construction firms have an in-

house design service and approved installation teams, project and site managers to ensure smooth delivery and installation of panel products onto a construction site.

The prefabricated nature of flooring cassettes therefore can have significant additional cost over traditional timber structural flooring practice, but these costs are recouped in reduced onsite construction programmes (Kingspan reports up to 40% less time on site, with an average time of around 45 minutes per panel, and two persons onsite), better resource (labour and material) utilisation, and tightening margins from more predictable cost, time and quality certainty compared to traditional construction.

Additionally, UK cassette flooring producers report that prefabricated construction methods allow direct savings in the region of 10% (20% for commercial projects), and retain a 5% saving in installed cost over traditional construction practices. Material waste is significantly reduced (30%), and delivery lead times for timber systems are cut by about 4 weeks.

Indirect cost benefits accrue from the ability to utilise lower skilled labour in a factory, the ability to handover the project earlier, reduced site security and lower insurance premiums. The actual savings from using these timber systems in Australia over alternative low-rise structural floor systems (such as concrete or steel decking), is highly dependent on the project and Australian building practices, and requires an independent project to quantify the full commercial cost benefits.

OHS issues

Offsite construction of flooring cassettes provides additional cost benefits through reduced OHS downtime, and a safer, cleaner construction site with less offcuts and site waste. Compared to UK statistics on the safety of traditional construction methods, offsite construction firm Yorkon cites an organisational increase in site safety of 46%. This is attributed to less cartage of materials to waste (so less vehicle movements on the building site); fewer tradespeople present on the site due to installing services in the flooring modules in the factory, and service scheduling and precision reduces the need to callback tradespeople throughout the building process. By undertaking much of the assembly inside a factory, Stewart Milne flooring cassettes claim to remove nine processes that contractors previously needed to perform on site. Loughborough University studies have also found the manufacturing sector is six times safer than the construction sector, so OHS risks are significantly reduced as these issues are easier to plan for and address in a

factory environment than a building site. This reduces the risks associated with working at height, and the need to have cutting and fastening equipment (i.e. saws and nailguns) set up on partly constructed upper levels.

Flooring cassettes require cranage equipment to lift and position into place. Many low-rise timber buildings currently do not utilise cranage, but use scaffolding planks instead, with manpower or simple pulley manhandling systems to position large members into position. Scaffolding systems are cheap in comparison to cranes, and do not have the same OHS preventative requirements. On the other hand, cranes on site for a short time reduce the amount of time that scaffolding equipment is used, and the risk of falling.

The move towards steel beams over garage spaces in second storey buildings, and the driver of open space living is increasing the use of steel beams or deep timber members. Therefore cranes are increasingly being used in lower-rise building applications. Already the housebuilding industry is moving to increased use of prenailed framing in Australia. Cassette floors is a natural progression to this trend and cranes are now normally used on housebuilding sites. They are normally relatively light weight cranes that could not handle concrete floor slabs. The requirements for cranage in low-rise commercial applications to install flooring cassettes may therefore be less of an issue, as the crane may be required anyway, however, this may enhance the usage of steel beams systems where glue laminated timber beams could be used instead.

Product features and benefits

Advantages

- Instant stability transmitted to the working platform - and an instant working platform to begin second storey construction
- Major reduction in the overall project erection time
- Reduces the need for OHS practices such as fall protection and scaffolding
- Dramatically improve efficiency and quality of construction
- Reduced site time reduces labour costs, and risk of OHS incidents
- Improved construction accuracy due to uniformity of cassettes
- Non-skills labour can be used in offsite factory production
- Brings improved productivity, increased operating safety during the construction process.
- Instant stability transmitted to the working platform and the consequent major reduction in the overall project erection time

Disadvantages

- Higher accuracy in substructure is needed i.e. lower storey walls need to be in right location. This is sometimes difficult when poor slabs are laid.
- Need building designs to be modular to gain economies in repetition, although prenailed framing systems have managed to easily adapt to cost-competitive one-off designs.
- Modification to building design is tougher with panelised system.
- Delivery schedules need to be coordinated with construction program.
- Increases crane use.

Strengths

The technology is incremental and can be added in the first instance to existing fabrication operations (e.g. frame and truss). The technology is already there in structural design, but requires attention to architectural design and site practices. It would suit low rise residential, aged care and health buildings – flooring cassettes are particularly useful in applications where the alternative is to use I-joist hangers fixed to rim beams by nails, and there is a substantial unsupported flooring span required, such as in long corridors (wings of hospitals, barracks and classroom blocks). In a case study from the UK, a building which used standard joist hangers took five teams of 3 persons busy installing the floor system, due to the large building area and the need to complete each floor before beginning upper-story construction (in order to maintain floor height levels). A cassette flooring system would provide the assurance of a level floor due to prefabricated high tolerance of components, and a ready made platform, thus the ability to begin on upper floors while the remaining floor was being installed. The decision not to use flooring cassettes was seen to have incurred a major cost implication for the erectors.

Flooring cassettes also offer the ability to include a composite floor with 35-45 mm thick concrete slab on-top, which improves sound performance and provides increased stiffness to the timber floor (subject to good shear connection – glue or protruding nails/screws). The cassette idea could also be applied to raftered roofs, in fact there are existing UK suppliers of roof cassette systems (smartroof; Tradis;). Anecdotal evidence suggests that there is less transport of materials to site, and reduced numbers of trips for the freighting company. The completion of a total set of timber prefabricated systems for walls, roof truss and flooring may allow one materials specification to channel into other applications (i.e. in choosing timber flooring cassettes due to the benefits of sound and thermal performance and reduced erection time, this may allow timber wall and roof framing to be

supplied from the same supplier, where previously steel roll-formed systems would have been used.)

There are significant build efficiencies:

- Buildings have fewer defects and can be built quicker
- Less waste is produced on site, and less site disturbance
- Increased safety on site means fewer worker accidents and less downtime days.
- Reduced call backs because of nail squeaks in poorly installed floor sheets

Weaknesses/Issues

The system requires standardised rectilinear floor layouts with regularly spaced structural supports, and may need to incorporate service penetrations. Therefore tolerances need to be accurate which requires a level of automation and in some cases CNC precision for service route alignment. Although the system is limited to low-rise applications, this type of prefabrication requires an experienced erection crew that is intimately knowledgeable of the system, for accurate installation, especially for more complex prefabrication systems. Factory labour costs are fixed regardless of output, and it is therefore difficult to react to fluctuating demand (i.e. you need steady and ongoing orders). Mass production is obviously preferable for set-up costs in the factory over batch production. This is also more difficult to automate and plan for unless there are standard building module lengths and depths that can be offered to clients, which requires the integration of designers to design to the module widths and lengths supplied. Due to the mass produced nature of the modules, if a problem is found post-construction with any component, it may be that many buildings are affected by this, due to replication of the system. Rain can penetrate the flooring panels and damage the flooring cassette if it is not protected during construction – this can have implications in negating the precision pre-finishing due to swelling or shrinkage.

Critical success factors

There are few barriers to overcome as this system is an extension of current components used already, packaged into a prefabricated system.

- Automation and design – whole flooring service solution
- Craning on site – not usual for low-rise timber systems but increasing due to inclusion of steel products in large span applications, and more sophisticated and larger spanning pre-nailed roof-trusses.
- Fixing mechanisms
- Tolerancing of components – requires CAD and automated factory production

- Service routes and ceiling fittings - pre or post production
- Panel size – maximum able to be freighted and load for spanning and craning into place
- Composite flooring has it's own idiosyncrasies: Acoustic performance can be improved by the addition of concrete topping over resilient layer or the addition of a false (access) floor over the cassette floor. (Wood-concrete composite floor utilising 30-50 mm of concrete is poured over a resilient mat. In the US/Canada, Gypsum concrete is used due to the added advantage of requiring less water to set, and enabling the ability to continue construction just 2 hours after pouring.)
- Skilled installation and support crew – to oversee the building project installation, liaise with subcontractors and project managers, and provide technical support and ensure quality control during installation of the systems.

Capital equipment requirements

Offsite production requires controlled optimising saws and automated panel lines, and the establishment of manufacturing centres dedicated to in-line production systems (especially if insulation and services are to be included in the cassette). Automated machinery is required for large production sites, otherwise most standard frame and truss and glue lamination equipment would be used.

Such equipment is expensive, and smaller operators can't afford the expensive automated equipment, or have no interest in growing larger or getting more sophisticated. There needs to be an incentive for a Frame and Truss supplier to expand their operation into this area of the market.

Integration with current building practice

- Storage on site would not be recommended, delivery would require to be scheduled with erection avoiding the need of – keeping the panels clean and out of the rain
- Delivery framework would be handled via existing frame and truss or modular systems suppliers
- There will be no difference in timber component production for sawmilling and remanufacturing plants
- The market growth and expansion is reliant on frame and truss producers, or specialised prefabricated panel producers starting to supply the market.
- The builders are resistant to change. Carpenters may feel prefabricated flooring takes away the need for their skills.
- There is currently a global building skills and labour crisis, and this is coupled in parts of Australia (particularly Perth, Sydney and Gold Coast) with an anticipated boom in low-rise healthcare and aged care facilities, as

well as a reduced but ongoing housing demand. Such a system may allow a solution to these two drivers.

Business operating model/ supply chain

- Via frame and truss systems in the first instance, with a view to the establishment of dedicated prefabricated flooring panel lines within frame and truss plants, and a large producer franchise supplying the market.
- Frame and truss industry would deliver to the site and site builders erect, as per roof truss installation currently.
- Requires frame and truss suppliers to build new relationships with project managers, project construction teams and site developers, in order to make the expansion of their business with this system, into commercial applications.
- This opportunity allows a total system package for prefabricated structural timber systems to be used in low-medium rise (2-3 storeys) non-residential applications, based on the prefabricated residential models such as MMC from overseas.
- Having a total, quickly erected on site, timber package may in turn allow timber frame and timber roof truss to be used in place of steel and concrete systems should the total solution be an attractive option – especially if fire, sound and stiffness issues are overcome through the use of composite flooring and MRTFC systems, and the system has other 'green benefits', such as reduced waste, safer site practices, and less emissions from material production and transportation to site.
- Ability to have a range of complexity in terms of technical solutions – from an open joist cassette that can be manually manufactured using pre-nail and gluing jigs, through to a fully automated and precision control factory assembly line that produces cassettes complete with insulation, fixing mechanisms, service routes etc.
- This system is most likely to be successful if targeting building types that lend themselves to a degree of modulation and a degree of economies of scale within the project. It could suit quite a few low rise residential, aged care and health applications. For instance the idea would probably suit townhouses as there are often quite a few on the one site which would spread the cost of the crane. The units also tend to have a standard width and so the cassettes could be standardised in length and simply be dropped into place. In some instances, floor cassettes could even be used as the base for loft construction.

Likely competitiveness of the system

Market size

An estimation of market potential for the system gives an increased capture for timber in the commercial sectors of around 3,000 m3 per annum:

CASSETTE FLOORS	annual # of units built*	Total floor area (000 sq m)	Average floor area per unit (sq m)	Estimated Volume of timber used per sq m of cassette floor (m3)$	Value per sq metre#	Total timber volume potential (m3)	% Potential timber MS£	Potential Volume capture (m3)
Likely applications								
• Education	2,934	2,420	825	0.003	$80-120	8,069	25	2,017
• Health	771		1,066	0.003	$80-120	2,740	15	411
• Aged care	420	1,270	1,066	0.003	$80-120	1,492	15	224
• Accommodation	621	812	1,308	0.003	$80-120	2,708	25	679
	4,746	4,502	1,066	0.003	$80-$100	15,009	22	3,329

** ABS figures for 2006 year: 8731.0 Building Approvals, Australia .Table 66. Number of Non-residential Building Jobs Approved, by Value Range, Original - Australia*

 # Estimated from Rawlinsons installed construction costs for timber joists/particleboard upper floor, including lateral supports and noggin to sheet ends and edges.

$ Based on a 200x 50 mm joist at 600mm centres, with 20mm flooring panel.

£ Branz estimate

Freedom to Operate

The system is fairly well-known and generic in nature, however patents have been found for these types of systems. The ability to operate with a standardised flooring cassette design (i.e. I –joist and particleboard floor structure, or a trussed joist assembly) would be unlikely to be challenged. Novelty added into such a system may obtain the right to patent, however.

There are many system brands available, and, similar to other timber products in the market, strong branding would be needed in order to distinguish a system of quality and to mitigate the impact of me-too start up panel prefabrication systems.

Summary

Business Proposition

- This is an opportunity for the prenail wall frame and roof-truss operations to expand their business and provide a prenail flooring cassette, and an opportunity for the timber suppliers of high-grade framing, LVL, I-joist, particleboard and plywood to increase timber supplies into the prenail marketplace.
- Flooring cassettes provide the timber building sector with a chance to compete head to head with steel decking, and pre-cast concrete flooring systems in low-rise (2-3 storey) applications such as health wards, school classroom blocks, and multi-use retail complexes. The

system provides a dry, fast erection process using a high-quality modular system.

- The ability to utilise truss parallel chord and I-joists, as well as provide a composite structure using a thin concrete layer poured over the floor surface once installed will mitigate timber flooring weaknesses of low stiffness (squeaking, sagging) and poor low frequency acoustics.
- The system allows prenail plants to choose from a range of complexity in the type of cassettes they wish to offer – from a simple open joist and panel cassette system through to a fully auto-assembled and machined cassette enclosing cabling and insulation – to suit the building application requirements.
- The system offers the potential for staged market entry, from
  - low rise residential truss and frame (which is an existing product in an existing market), to
  - low rise residential cassette flooring (new product in an existing market, or could be thought of as a line extension from truss and frame), to
  - low rise commercial/industrial applications of cassette flooring (new product into a new market) to
  - enhanced cassette flooring (eg improved sound transmission or fully prefabricated units with insulation and cabling installed)
- There is significant market potential to increase the volume of timber that can be utilised for such systems. This provides the timber sector with new outlets for these timber components to be sold, and the opportunity for further market growth. The possibility of NZ and Pacific export is also highly likely once the domestic market is established.
- An improved wood flooring system might improve the overall competitiveness of timber construction (walls, floors and roof) versus steel and concrete.
- The cassettes contain similar timber components to standard timber flooring, and therefore are unlikely to be any more negatively impacted by restrictions from Building Code requirements.

Competitive Advantage

- The advantage of this timber flooring system over current steel and concrete offerings include the dry process, simplicity due to modularity, and lightweight nature of the panels. This will speed up erection and reduce cranage requirements, and OHS risks. The panels should be cost effective, and offer environmental advantages.
- The opportunity suits low-rise building applications, which are already used to using prenail framing. The system can also be used to complement steel framing and concrete wall structures (i.e. it does not rely on using any particular wall system).

- Off site production ensures high quality standards, less skilled labour needed and limited waste on-site.

Challenges and suggestions to overcome them

The need for partnering with frame and truss industry to ensure supply chain delivery	• The timber industry has established strong linkages with the F&T manufacturers, and there exists the ability to use existing delivery routes
Timber's reputation as having less quality – low stiffness and acoustic quality	• The MRTFC project has enhanced timber reputation for flooring systems. • Cassettes offer the ability to use I-joist and parallel chord truss systems (even timber-steel joist systems) for additional stability; The ability to incorporate insulation, services or include acoustic solutions to mitigate sound concerns.
Timber industry apathy to taking this up	Suggest that FWPA or a key industry advocacy group approach companies producing the core cassette building components (LVL, I –joist, Steel/ timber hybrid joists, particleboard and plywood), as well as frame and truss manufacturers, pitch the idea, and act as a conduit to bring these companies together in this initiative. This may need to be a funded development project – multi-company.
New fixing mechanisms	Joist hangers are time consuming to install where a multitude of joists are required. Use Pryda and Mitek linkages to adopt international fixing brackets for cassette floors, or to develop specific brackets for the Australian market.
Transportation to site and craning into position	Similar to prenail truss installation. Training of cassette flooring installation practitioners who are proficient with the system to be on hand during installation stage.
Keeping system dry during construction	Only freight to building site from warehousing facility or supply depot when required (this requires additional thought in terms of frame and truss operations and proximity to the site). Alternatively, use a weathering barrier plastic wrap that is removed prior to the flooring finish installation.
Automated equipment set-up at prenail plants	This requirement depends on the type of cassette being produced – less sophisticated

	cassette modules will likely allow assembly using simple glue and nailing jigs. Nail plate manufacturers should be involved to develop systems to solve this issuse
There is little proficiency in timber engineering around cassette flooring practices or composite flooring systems in Australia	Invest in a study tour to upskill practitioners in this system, and the latest technologies and know-how from UK and Europe. Places and companies to contact to upskill in the first instance: • UK Timber Framed Association • Gitterbjelke • APS systems • Prestoplan • Stewart Milne Timber Solutions • Stora Enso • BRE Offsite Exhibition, UK

Conclusion

- There appears to be a sizeable opportunity for such a system, which would not only increase the penetration of timber systems into the low-rise commercial sector, but includes spin-off benefits in terms of site safe practices, environmental benefits and star ratings opportunities, and offering a solution for current building skill shortage through factory-based construction.
- The cassette flooring system that would be of most benefit in an Australian sector is an I-joist box construction, open at the ceiling, with either ply or particleboard flooring. This system utilises the recent timber marketing efforts into engineered wooden I-beam flooring products as a solution to squeaking floors, allows an incremental improvement over joist and hanger systems (i.e. not jumping straight to a fully automated and insulated cassette) while introducing the prefabricated timber floor concept to the building sector.
- There is vast knowledge to be gained from the UK timber flooring offsite production sector, and the industry should build on the knowledge gained to date by this UK timber industry.
- The benefits are difficult to quantify as every project is different, and therefore, a project to compare a timber cassette flooring option over other flooring types on a real building project case example is required. (e.g. Such a feasibility study was undertaken for multi-storey timber construction in New Zealand by Mark Moore[21])

[21] Moore, Mark. Scotia Place – 12 storey apartment building. A casestudy of high-rise construction using wood and steel – WCTE. NZ Timber Design Journal Vol 10 Issue 1.

Recommended next steps:

1. Pitch the idea to a group of timber component manufacturers (LVL, board, ply, I-joist etc.)
2. Investigate a study tour to upskill knowledge around these systems, requirements, and the potential for franchising or adopting best practice solutions. Use the UK contacts in the first instance.
3. Undertake case studies on recently constructed healthcare and educational projects in Australia. Interview key personnel involved in materials specification and examine reasons why cassette flooring may have or might not have been suitable for such a project. Seek to understand the key supply chain and institutional barriers to use for these applications.
4. Further work could involve a pilot trial involving an interested Frame and Truss manufacturer, in order to establish business risks and issues with production and project delivery mechanisms.
5. Ultimately, a demonstration project utilising cassette flooring should be undertaken.

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Advanced Panel Systems : www.sellecknicholls.co.uk/aps.htm
Finnframe : http://www.dontim-eng.co.uk/products_timber.php4
Acacia timber : http://www.acaciatimber.com/FloorCassetteSystem.asp
Kingspan: www.kingspan**offsite**.com
Stewart Milne: www.stewartmilne.com

Buildings surveyed

ID	Type	Storeys	Floor area Sqm	Main frame Type 1	Main frame Type 2	Exterior wall infill frame Type1	Exterior wall infill frame Type2	Internal wall/ partition frame Type1	Internal wall/ partition frame Type2	Roof frame	Ceiling battens	Substitution potential
BRANZ surveys												
1	Health	5	21,000	Concrete frame		75% conc panel	25% metal panels	95% steel@600ctrs	5% masonry blk	Concrete slab	No	Timber frame Partitions
2	Office	4	11,730	Concrete frame		100% metal panel		95% masonry blk	5% steel @ 600	Steel	No	
3	Office	6	20,708	Concrete frame		100% metal panel		100% masonry blk		Steel	No	No
4	Health	4	9,754	Concrete frame		72% masonry blk	28% metal panel	79% steel @ 600	21% masonry blk	Concrete slab	No	Timber frame Partitions
5	Entertain	2	2,041	Concrete frame	Steel frame	64% masonry blk	2% timb, 34% stonework	87% masonry blk	13% timber @ 600	Timber	No	
6	Entertain	2	1,240	Concrete frame	Steel frame	77% conc panel	23% masonry blk	65% masonry blk	35% steel @ 600	Steel	No	
7	Retail	1	7,583	Steel frame		100% conc panel		52% masonry, 26% SP, 16% timber, 6% steel		Steel	No	
8	Health	5	25,720	Concrete frame		65% masonry blk	35% metal panel	87% steel @ 600	13% masonry blk	Steel	No	
9	Retail	2	32,578	Concrete frame	Steel frame	58% masonry, 29% conc panel, 13% steel.		55% steel @ 600	45% masonry blk	Steel	No	Timber replace ext wall steel studs
10	Apartmts	6	4,110	Concrete frame		Ritex (steel frame)		Ritex (steel frame)		Timber	No	
11	Apartmts	9	11,686	Concrete frame		92% masonry blk	8% steel	60% steel, 35% Hebel, 5% masonry blk		Concrete slab	No	
12	Apartmts	6	10,685	Concrete frame		100% masonry		50% steel, 32% Hebel, 18% masonry blk		Concrete slab	No	
13	Retail	2	2,926	Concrete frame	Steel frame	100% masonry		100% masonry		Steel	No	Timber roof
14	Apartmts	8	6,891	Concrete frame		97% masonry	3% steel	49% steel @ 600	51% masonry blk	Steel	No	
15	Office	28	43,218	Concrete frame		100% masonry		100% masonry		Concrete slab	No	No
16	Hotel	5	4,589	Concrete frame		93% Hebel panels	7% masonry blk	92% steel @ 600	8% masonry blk	Timber	Yes, timber	Timber frame Partitions
17	Hotel	8	7,582	Concrete frame		96% Hebel panels	4% masonry blk	72% steel @ 601	28% masonry blk	Timber	Yes, timber	Timber frame Partitions
18	School	1	550	Steel frame		72% brick	28% timber frame	100% brick		Timber	No	Timber frame Partitions
Scion surveys												
S8	Backpackers	3	373	Concrete frame				Concrete	Timber	Steel		
S9	Hotel	1	1,200	Masonry				Steel		Steel		
S11	Retail/ resid	3	900	Masonry				Masonry	Steel	Steel		
S22	Offices	3	600	Concrete frame	Steel frame			Steel	Timber	Steel		
S32	Offices	3	2,000	Concrete frame	Steel frame			Masonry	Timber	Steel		

ID7 Internal wall, SP= sandwitch polystyrene panel.
ID10, Ritex is fibre cement sheet bonded to steel stud framing

All BRANZ survey floors were slab and concrete beams.

Survey of Building Blueprints

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