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Improving timber cladding for builders and designers

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Improving timber cladding for builders and designers

Prepared for the

**Forest & Wood Products
Research & Development Corporation**

by

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Executive Summary

This project aimed to improve the competitiveness of timber in the domestic construction cladding market by gathering information about preferred features of timber cladding systems, followed by physical development and prototyping of a timber cladding system.

The literature review and industry survey phases of the project served to generate ideas for product development. These stages also identified that timber cladding should try to develop points of difference from competing cladding products and should move from being an *ad hoc* kit of components to an integrated construction system. In addition, it was found that there are trends in the upper end of the housing market towards modern facades with sleek and minimalist detailing. Typically, lightweight materials (especially timber cladding) are used to visually counterbalance and combine with the appearance of masonry, steel and glass finishes. In terms of product development there was support for timber being integrated into this aesthetic via a flat faced board with a strong deep shadow line and by the use of stained or naturally finished boards. New trends in environmentally sustainable architecture were also found to encourage the use of lightweight cladding in hot and humid parts of Australia (e.g. Queensland) which have advantages over the thermal mass of heavy masonry.

Findings from the previous stages of the project were used to develop new components or variations on traditional components to form an integrated cladding system (the Flatline System). It features a board with a raked tongue and groove which allows easier installation onsite. A larger than normal board overlap improves weather resistance and facilitates hidden nailing. The system incorporates the concept of a metal cavity batten that offers an alternative to direct nail fixing and is well suited to hot tropical and high wind climates. The batten is also designed for improved weatherproofing, installation efficiency and thermal performance. A metal plate connector has also been developed which facilitates end joints between boards, thus removing the need to join boards over studs - cutting is reduced, waste is minimised and board setout is simplified. A factory applied stain primer can be used instead of a traditional paint primer. It can be top coated onsite with either stain or an opaque paint finish. New stain coating technology provides the ability to attain deeper penetration into the timber, thus presenting the prospect of greater dimensional timber stability. Finally, the system features a selection of new flashing options including exposed bent metal flashings and timber capping with concealed flashings behind. Features of the various options include the ability to fix metal flashing in a way that is hidden from view, to provide a straight edge and stop edge for laying cladding boards and to aesthetically express or suppress the exposed parts of metal flashings.

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1 Introduction

This report outlines the major findings and outputs from of a project aimed at improving the competitiveness of timber in the domestic construction cladding market. The project came about as a result of calls from the timber importer segment of the industry to address the decline in sales of timber cladding. Specifically, the objectives of the project were to:

- Conduct a market place assessment of the current cladding market to assess advantages and disadvantages of timber cladding, relative to other claddings.
- Develop technical product features that will improve demand for timber cladding among customers reliant on supply and erection efficiency.
- Develop appearance features that will improve demand for timber cladding among customers specifying cladding for appearance and end function reasons.
- Make timber cladding a value added product that saves work on-site and works effectively as a cohesive construction system.
- Improve the perception of timber cladding as a modern and quality cladding system.
- Develop a system that meets environmental issues including bushfire resistance.
- Help the Australian timber industry learn about cladding technology practices used elsewhere, and assist adoption of appropriate technologies locally.

The above objectives have been achieved by the project including:

- a literature review of cladding practices,
- a survey of builders and architects preferences for a new timber cladding system,
- a cost and technical feasibility study (of builder and architect preferences),
- development and prototyping of a cladding system, and
- development and dissemination of a template quality installation manual (for the cladding system).

2 Findings from the Literature Review

The literature review generated issues and ideas for product development. It identified that timber cladding should try to develop points of difference from competing cladding products. It also identified that there was virtually no integrated timber cladding systems in Australia while many competitors offered comprehensive alternatives.

In terms of market segmentation, it was concluded that many weatherboard products have large and well established product ranges in the low to mid priced housing segments. To avoid market saturation and to avoid competing on cost alone, timber would be best to target development at mid to high priced housing segments, especially custom designed houses and the prestige end of the volume housing sector. In time, winning such markets may eventually influence design trend in lower priced housing markets, thus creating a trickle-down effect.

Technically speaking, the review identified that timber cladding systems should integrate efficiently with the thermal and weatherproofing requirements of overall wall systems. Timber needs to address the durability of finishes, especially stain finishes. It must also provide an array of metal flashings, corner capping components and off-stud joiners to compliment the system and to achieve modern aesthetic requirements. This is also crucial in providing a more systematised approach. From a builder's perspective there is also a need to deal with site fabrication and erection issues including advanced fixings, materials handling and scaffolding issues.

The review also identified that even though aesthetic design is difficult to formularise, home-buyers and architects appear to want a more modern and minimalist facade design. This especially occurs in the mid to upper quality housing segments and as alluded to previously this is likely to be the most productive area for timber cladding to focus ongoing development.

A variety of specific issues were identified from the literature review which was used as a basis for questioning builders and architects about their preferences for timber cladding systems. The findings from that stage of the project are reported below.

3 Findings from the Industry Survey

The industry survey - which consisted of in-depth interviews with builders and architects – was generally supportive of findings from the literature review in terms of the need for timber cladding to move from being an *ad hoc* kit of components to an integrated construction system. In doing so, the main competitor for timber cladding was identified as being the “top-end” architectural fibre cement cladding products. To be successful, timber cladding must be able to match generic features of such systems and concurrently provide a number of unique features that differentiate it in appearance, functional performance and construction efficiency. Timber cladding must also carefully target specific customer/market sectors. Details are discussed below.

Trends in Modern Facade Design

- Modern facades typically use lightweight materials (including timber) to visually counterbalance heavy masonry and hard glass finishes.
- Use of lightweight claddings allows contrast in terms of colour, pattern and/or texture. In particular, timber achieves this in a desirable way via shadow lines at board laps and via the warm natural appearance of stained or naturally finished boards. Paint finishes are also possible but compete more directly with other cladding products such as fibre cement.
- Modern facade designs feature a refined appearance that is minimalist in detailing (including possible use of expressed joints). Timber has yet to address this area of design.
- Lightweight claddings appear to be particularly popular in hot and humid parts of coastal Queensland.
- Modern facade designs are typically used in customised and upmarket houses (Figure 1).

Figure 1: Timber cladding in modern housing designs



Who is the best Customer for Timber Cladding to Target?

- Those involved in modern, up-market and custom designed homes are the best group for timber cladding to target. This includes architects and custom design and construction contractors. They identify with being trend-setters and relate to the modern facade concepts described previously.
- Prestige housing estate developers and associated housing contractors represent the second best market and identify with being “active trend followers” of the modern facade concepts described previously. Their houses will be more expensive and will have greater emphasis on perceivable design qualities than main flow project homes.
- In conjunction with the above, timber is likely to be especially well received among architects and their clients when building in coastal, country or other

natural settings. Timber cladding may also be used in urban settings but mainly where architects and their clients are open minded to new and different forms of modern architecture. Timber cladding is less likely to be used in areas where conservative architecture predominates e.g. project homes.

Timber Cladding Treatments and Finishes

- The single most important feature differentiating timber boards from other materials is its warmth and natural appearance, as recognised through stain and natural finishes. At odds with this, timber's single biggest weakness is its poorly perceived dimensional stability, durability and most of all its high maintenance of stain and natural finishes. This significantly limits its uptake and usage.
- Given the previous point and technology permitting, stain and natural treatments should target at least a seven year period before recoating in order to cover the statutory warranty period on defective work for builders. A ten year warranty would be ideal as this would allow stained timber to be marketed as having the same re-coat life as painted timber, fibre cement and painted masonry finishes.
- There is strong demand for a pre-stained timber board. It would need to offer a high quality finish and be beneficial if it could be top coated onsite with either stain or conventional opaque paint finishes (as desired).
- In terms of surface texture there is much stronger demand for dressed timber boards than rough sawn timber boards.
- Timber cladding should incorporate a cladding solution for building in bushfire prone areas including the use of fire retardant treated timber that meets regulatory requirements.
- In very expensive houses, high levels of customisation may mean that only parts of an integrated timber cladding system would be used. There may also be resistance to say pine cladding boards in preference for more highly regarded timbers such as native hardwood species.

Timber Cladding Profiles

- An advantage that timber has over other board products is its thickness. Bearing this in mind, there is support for a new board profile based on modifications to the traditional shiplap profile. It would have a deeper but narrower rebate thus creating a strong shadow line. Other cladding products would have difficulty mimicking this style.
- An important feature is the need for a hidden fixing system.
- Another important feature is random end matching of boards. This would reduce waste and onsite cutting. It would also avoid having to join boards over studs.
- Timber cladding in standard pack sizes and with precision square cut ends makes ordering more predictable than previous approaches such as random length slings; storage onsite becomes simpler and less prone to twisting and warping; boards can be placed in position straight from the pack or only need trimming at one end. The need for standard length boards is also consistent with competing products in the market place.

Associated Wall System Features

- New timber cladding systems should incorporate the ability to benefit from cavity construction (i.e. thermal performance, space for running services, improved moisture management) but this should be provided separately to the core cladding system.
- There is strong support for incorporating preformed flashings, capping and cover moulds into new timber cladding systems because these components help provide and define an overall construction system. Allowance should be made to incorporate the ability to provide a limited range of expressed joints to satisfy architectural demand.

Supply and Erection

- Timber cladding construction is seen as being expensive.
- Findings indicate that supply of timber cladding systems is best targeted towards outlets that normally supply eaves and external fitout materials. Carpenters fitting such materials are also likely to be the best placed to do the installation work.

Communication

- Architects need to be able to specify construction systems to builders. Of note, this includes the ability to download drawing details and specifications.
- Environmental sustainability is an issue which should be marketed via communication of general measures taken in the forestry and supply chain endeavours.

4 Findings from the Feasibility Stage of the Project

This stage involved determining which of the previously defined cladding system features would provide the best value adding options for timber cladding. Each of the main items are discussed below under appropriate headings.

Factory Based Stain Primer Coating for Boards

A variety of different coating and timber treatments were analysed in terms of cost and technical feasibility as a means of dealing with aesthetic, colour durability and dimensional reliability needs. At the time of conducting the study, none of the options was advanced enough in development to meet ideal requirements with any certainty. However one of the technologies – the Uroxsys P/L “Silvaseal Primer” being an organic/inorganic hybrid system – was concluded to offer the most potential in terms of meeting ideal goals. For instance, it could act as a flexible factory applied primer which could accommodate site top coating using stain or opaque paints. Though acting as a primer, its deep penetration offered the potential of addressing long term colour fastness of stain applied coatings (as witnessed from test results). Its intended ability to carry fungal, termite and fire retardant treatments into the timber, thus replacing the need for conventional LOSP treatment, could serve to offset increased application costs and also simplify the timber manufacturing process. As a result, it was decided to pursue this technology as part of the ongoing development.

Timber for Bushfire Prone Areas

Despite considerable industry interest about bushfire resistant timber, technology in this area was not found to be well enough advanced for use in a timber cladding system. In reaching this conclusion, three generic approaches were explored including:

- Naturally fire retardant treated timbers which were already in use under AS 3959 but was not applicable to the pine cladding coming out of New Zealand.
- Factory applied fire retardant treatment which probably offers the main future for softwood products and could potentially be facilitated using the previously discussed coating technology.
- Site applied fire retardant (intumescent) paint which currently exists in the Australian market but is hampered by its high material cost and requirement for a five coat system. As a result, it will likely remain too expensive for mainstream applications.

As a result, the project objective of incorporating bushfire resistance into timber cladding could not be addressed as an ongoing feature of product development. What can be said is that this area requires significant additional technical development in order to come up with a commercially viable and common place solution that will adequately meet market needs.

Hidden Fixing for Boards

Cost and feasibility issues were explored for two hidden fixing options:

- Tongue and groove boards with an increased overlap to hide nail fixings.
- Metal battens with protruding tabs fitting used to back fix boards to the wall frame.

Apart from the benefit of hidden nailing, the first of the above options offered reduced labour and materials by virtue of only requiring one nail per board, per stud (instead of two). There was also reduced labour and materials in terms of removing the need for

punching and filling nail holes (for painting). On the downside, the extra board overlap reduced the effective cover of the boards, thus increasing the amount of board required to cover a given area of cladding. The net effect to cost of these changes was estimated to be negligible, thus encouraging development of this approach as part of the ongoing cladding system development.

The metal batten approach was less predictable in terms of estimating cost change. Batten material and installation costs would clearly increase but would largely be offset by the improved fixity, improved weather resistance, improved thermal performance and improved board installation efficiency. Notably, these features tend to overlap in hot, tropical, cyclonic wind environments as occur in the far north of Australia. As such, the cost viability of this approach was considered to be linked to its use in these sorts of environments.

End Connector for Boards

Three options were considered for random end jointing of boards:

- Boards with end matched tongue and groove detailing
- Boards with end matched grooves and a connecting spline
- A metal end connector that joins boards ends together

Weatherproofing issues, site practices and practical machineability issues were found to adversely effect the first two options. For instance, end grooved boards would be hard to weatherproof and to protect against entrapped moisture. It was also apparent that tongue ends would regularly need to be docked off during installation and this may ultimately create more work than it saves. Preference was therefore given to a folded metal plate connector approach where material costs and product development costs were likely to be inexpensive. Such an approach could also incorporate butt jointing of boards thus doing away with finicky and time consuming traditional practices such as scarf jointing of board ends.

Standard Pack Sizes of Square Cut Boards

Technical and cost investigation of this issue indicated that providing both standard length packs and boards with accurately square cut ends represented a relatively inexpensive and worthwhile value adding option that should convert to improved perceptions among builders. The actual lengths to be supplied was found mainly to be a logistics issue as driven by stock control and shipping requirements. As a minimum, it is considered that lengths of 5.4 m should be supplied.

Preformed Metal flashings

Preformed metal flashings were demanded by architects and contractors to simplify construction and improve appearance. The option of extruded aluminium flashings was found to be too expensive and difficult to supply without significant up-front capital investment. As a result, folded sheet metal flashings were preferred in terms of cost, availability, simplicity, control over flashing needs and site specific design flexibility. Folded metal flashings can also be ordered in long lengths (i.e. up to 8.0 m) thus reducing unsightly joins on site.

5 Cladding System Development and Prototype Testing

Findings from the previous stages of the project were used to develop new components or variations to traditional componentry to ultimately form an integrated cladding system. This involved both product design within TDA as well as partnering with external companies Uroxsys, Pryda and Selleys. The individual components of the system culminated in construction of a prototype building measuring approximately 4.3 m long x 2.1 m wide x 2.7 m high (plus gable roof above) as shown in Figure 2.

The prototyping process allowed various aspects of the cladding board design, hidden nailing system, metal cavity batten system and end jointing system to be evaluated, rationalised and modified accordingly. Full details of the system are available at www.timber.net.au/flatline.

In general, the design of the system aimed to fit in with the existing “deemed to satisfy” housing provisions of the Building Code of Australia. As a result, there was no express need to undertake first principles testing of the system. Despite this, some of the products and technologies utilised in the system did not (do not) fit into the context of the BCA housing provisions and would therefore benefit from ongoing monitoring of condition assessment. To facilitate this (albeit not part of this project) the prototype building has been located in an external seaside environment.



Figure 2: The Flatline prototype building

6 The Flatline Timber Cladding System – An Overview

The Flatline System converts the previous project stages into a finalized cladding concept. As alluded to previously, the system is based on the use of Radiata Pine cladding boards but with adjustments it could also be applied to other species. The system aims to improve timber cladding from being an *ad hoc* kit of components to an integrated construction system. The system also aims to be able to compete with the features of non-timber cladding systems while providing a number of unique features that differentiate it in appearance, functional performance and construction efficiency.

As discussed previously, the Flatline System responds to market research concerning trends in housing design and construction. Of note, there are trends in the upper end of the housing market towards modern facades with sleek and minimalist detailing. Typically, this includes use of lightweight materials, especially timber cladding, which is used to visually counterbalance and combine with the appearance of masonry, steel and glass finishes. In particular, timber can achieve this in a desirable way via a flat faced board with a strong deep shadow line, a feature which architects see as a desirable alternative to splayed boards. It is also hard for non-timber board products to copy this approach. Lightweight cladding is also in demand in hot and humid parts of Australia (e.g. Queensland) where well ventilated buildings have advantages over the thermal mass of heavy masonry. Flatline aims to take advantage of these trends.

The main customer base likely to respond to the Flatline System (and the above design trends) includes:

- Those involved in the design of modern, up-market and custom designed homes.
- Those involved in prestige housing estate developments.
- Those designing housing in coastal, regional and tropical areas.

Flatline's Board Profile

Flatline provides a new board profile suited to all horizontal and/or vertical cladding situations as well as ceiling, gable and eave installations. The board profile (refer Figure 3) incorporates a deeper rebate and therefore a deeper shadow line than similar board profiles. The board also features a raked tongue and groove which allows easier installation onsite. A larger than normal board overlap also improves weather resistance and facilitates hidden nailing. Grooves machined into the opposing faces of the overlapping boards also create a 2 mm wide anti-capillary groove which aims to improve weather resistance.



Figure 3: Conceptualised view of the Flatline board profile

Flatline’s Hidden Nailing System (for non-cyclonic wind zones)

The Flatline System adopts a different approach to traditional nail fixing of cladding boards. For instance, nails are located centrally in the anti-capillary groove of the board (refer Figure 4) and as alluded to earlier in this report, nails are ultimately hidden by virtue of the enlarged overlap between boards. There is also only one nail per board per stud. As a result, there are no nails seen on the outside face of the cladding and so an associated advantage is that there is no need to punch, fill and sand nail holes. This also makes it possible to pre-coat boards prior to erection, requiring only touch-up or minimal finishing coats once installed.

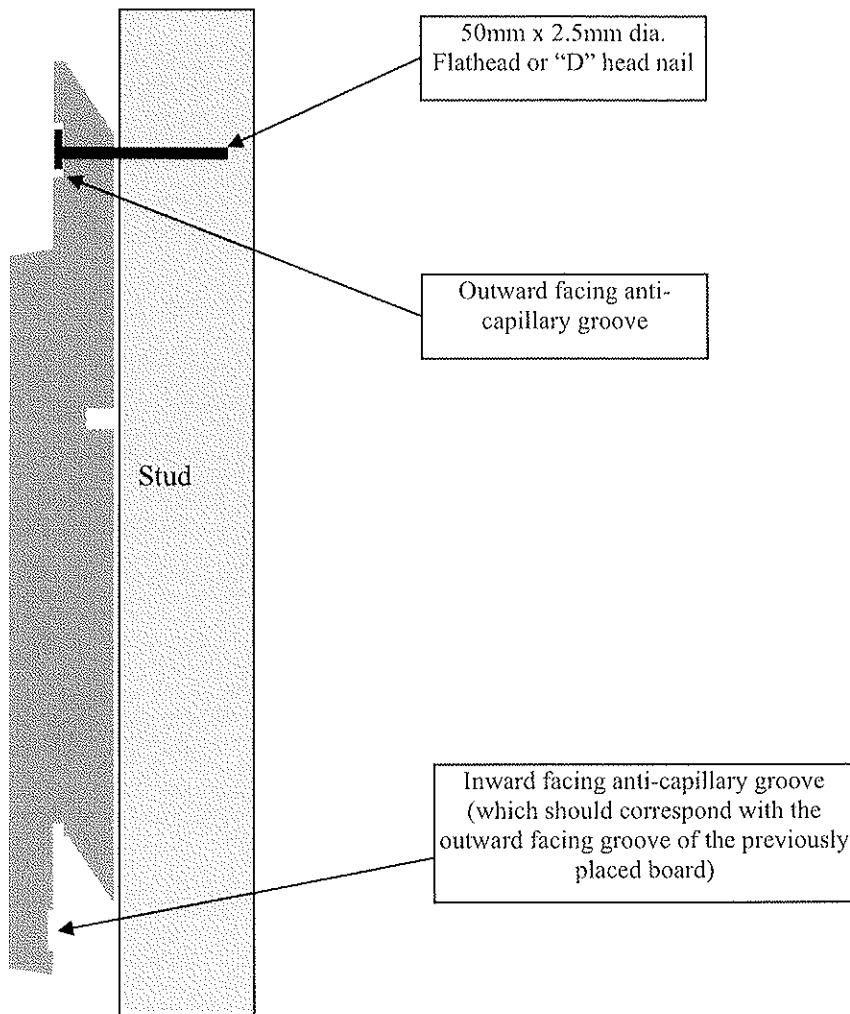


Figure 4: Nail positioned in anti-capillary groove

Flatline's Cavity Batten System (for tropical, high wind areas)

The Flatline system incorporates the concept of a metal cavity batten that offers an alternative to direct nail fixing and is well suited to hot tropical climates. The concept was designed to perform well in high wind areas (i.e. greater than N3) while still providing a hidden fixing system¹. Here, the battens are fixed to studs (max. 600 mm spacings) and the metal holding fins protruding from each batten fold down the rebated face of the boards. This aims to provide greater resistance to board pull off forces than nails. The battens are also designed for:

- *Superior weatherproofing* i.e. the cavity assists drainage of rain that may occur in high wind driven rain environments
- *Improved installation efficiency:*
 - The battens can be quickly gun fixed through the metal into the face of studs.
 - Setout, alignment and installation are simplified because boards hook into position between the pre-determined fold out fins.

¹ AS 4055:1992 *Wind Loads for Housing, Standards Australia, Sydney*

- Improved installation speed i.e. boards simply slot into place between the fold out fins which are then bent over the top of boards with a hammer
- *Improved thermal performance* i.e. the air cavity contributes to insulation and the performance of reflective air spaces. Thermal performance software programs such as AccuRate can model the cavity space as either a ventilated or non-ventilated cavity depending on hot or cold climate conditions.
- *Battens can be used to hold sarking in place* i.e. by tacking the top of the sarking in place, then using the over fixing provided by the battens to hold the rest of the sarking in place.



Figure 5: Metal battens fixed to the face of studs with fins protruding

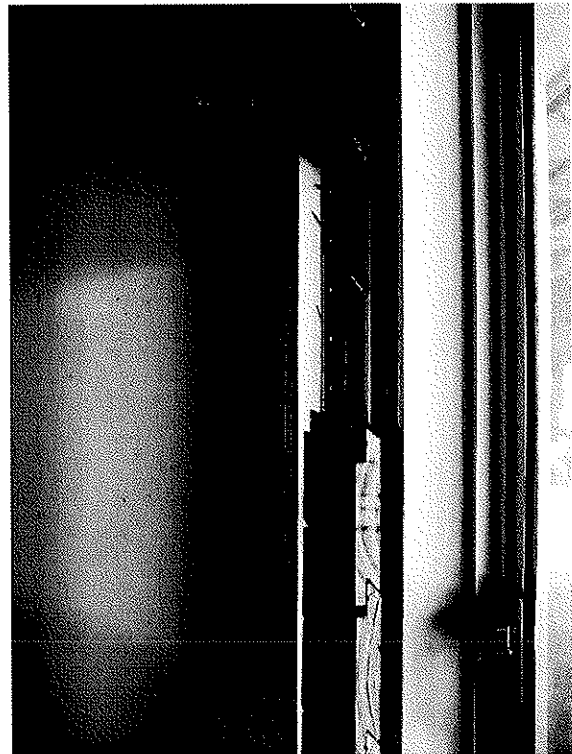


Figure 6: Side view of boards placed in between fins protruding from batten

Flatline's Random End Jointing of Boards

The Flatline system incorporates the concept of a metal plate connector (refer Figure 7) which is applied with adhesive to make end joints between boards, thus removing the need to join boards over studs. Key advantages are that site cutting is reduced, waste is minimised and board setout is simplified. The first step in making the joint involves removing 20 mm of the back shoulder of the tongue from the ends of the two boards being butt jointed. This and the other steps are shown in Figures 8 to 10.



Figure 7: Metal plate connector

Figure 8: Chisel cut used to remove back shoulder of tongue

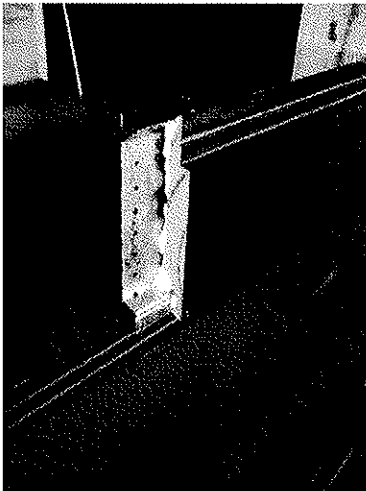


Figure 9: Connector (with adhesive applied) fitted behind board

Figure 10: Close up of completed joint (prior to final staining)



Flatline's Stain Based Factory Primer

Timber cladding's biggest advantage over other cladding boards is its ability to be finished with a natural or tinted stain. The warmth of this provides the perfect visual counterbalance for visually cold materials such as steel, concrete, glass and rendered masonry. Concurrent to this, timber's greatest weakness is its poorly perceived durability including it's:

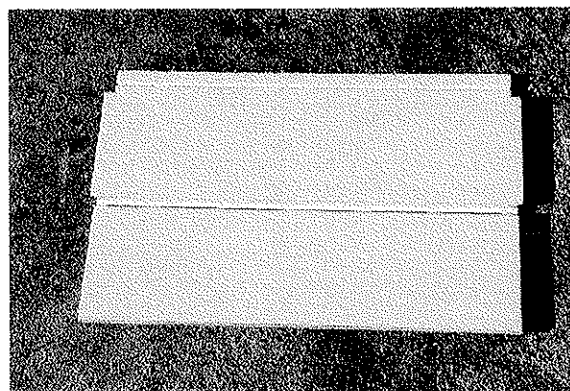
- Short recoating period for stains
- Poor dimensional stability (induced through change in moisture content)

The concept of a stain primer (instead of an opaque paint primer) aims to go some way towards addressing the above issues (Figure 11). The stain primer can be applied with much the same factory equipment as opaque paint primer but provides greater flexibility in terms of what it can deliver as an end appearance (Figure 12). For instance, stain primer makes it possible to top coat onsite with either stain or an opaque paint finish. In addition, by using a light coloured stain primer there is the option of using darker stain top coats to vary the final appearance. This allows designers many aesthetic options from the same base product. New coating technology also provides the ability to attain deeper penetration into the timber, thus presenting the prospect of greater dimensional stability. In time, such coatings may potentially be used as a vehicle for treating timber against rot and termite attack.



Figure 11: Silverseal stain primer over finger jointed radiata pine

Figure 12: Opaque acrylic paint applied over Silverseal stain primer



Flashings, Corner Mouldings and Capping

Users of the Flatline System have the option of using their own flashing systems or a selection of new flashing options provided as part of the system. This includes two key types:

- Exposed bent metal flashings (in Colorbond or stainless steel)
- Timber capping with concealed flashings behind

A number of these options are shown on the following pages. Of note, one of the stainless steel corner flashings is shown in Figure 13. A new bent metal flashing that can be applied around windows and other flashing applications is shown in Figure and Figure. Aesthetically, it provides a slim but expressed band around window/door units that can be used to either contrast or meld with surrounding construction elements. In addition, Figures 16 to 18 show timber stop mould and timber capping options.

Features of the various options include:

- The ability to fix metal flashing in a way that is hidden from view – this also prevents the aesthetic problem commonly known as “oil canning”
- The ability to provide a straight edge and stop edge for laying cladding boards
- The ability to either express or suppress the exposed parts of metal flashings
- The ability for metal flashings to be bent to deal with most offset wall angles
- The ability for head and sill flashings to maintain a small air cavity to help prevent wind blow rain from rising up behind the flashing



Figure 13: Example of stainless steel bent metal external and re-entrant corner flashings



Figure 14: Example of Flatline's bent metal window/door flashings

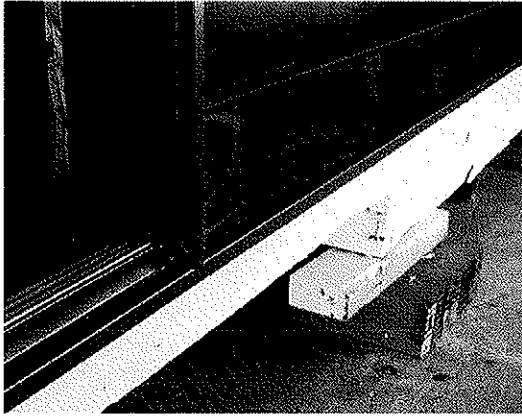


Figure 15: Cladding base (starter) flashing

Figure 16: Perspective view of timber corner mould

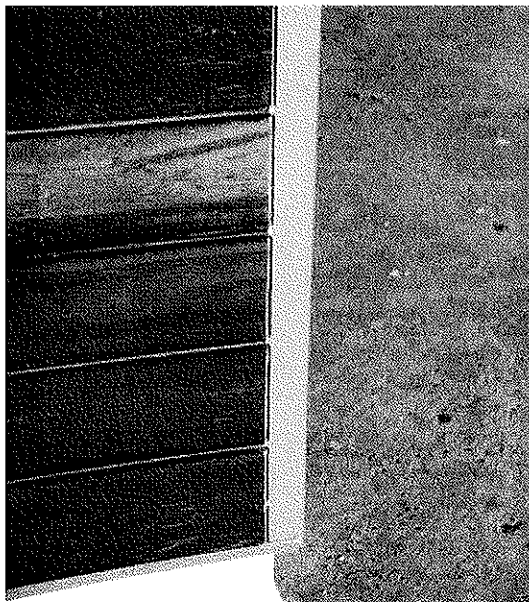
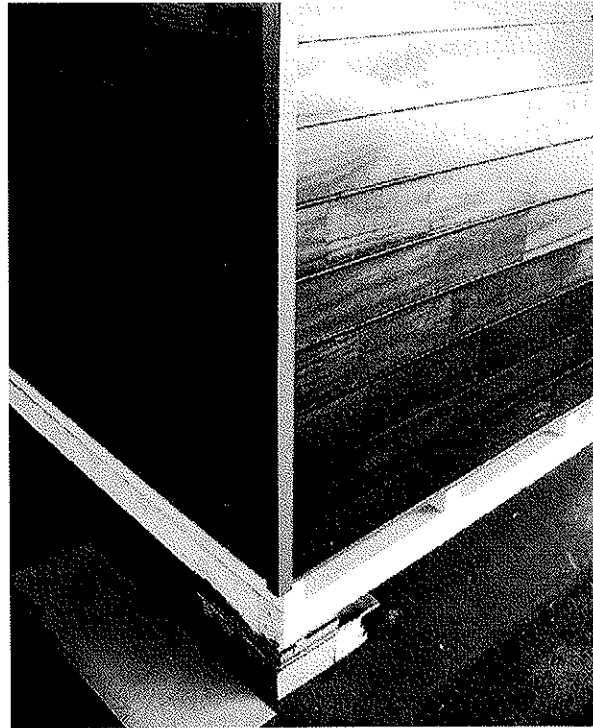


Figure 17: Side view of timber corner mould (with shadow line)

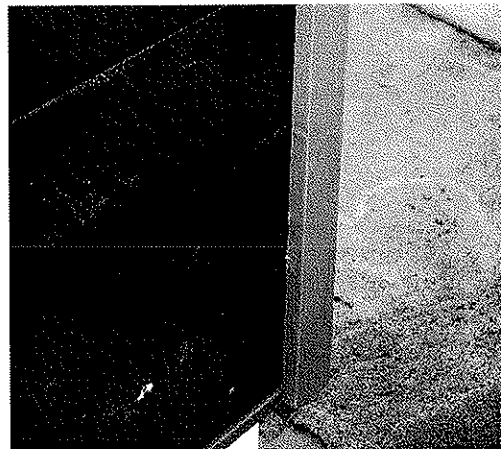


Figure 18: Close up of (alternative) corner capping

7 Conclusions

Commercial Implementation of Results

The Flatline system has been promulgated to interested parties in the timber industry by way of a series of detailed briefings and seminars. It's ongoing and more detailed implementation is primarily via a template quality installation manual which can be downloaded at www.timber.net.au/flatline. Importantly, the system offers concepts for suppliers and marketers to adopt under their own branded versions of the Flatline System. As a result, the template manual is primarily an aid for individual companies to create their own "branded" installation manuals.

The web site has been specifically designed to monitor and encourage uptake among those involved in the timber supply chain. For instance, in addition to the above mentioned manual, it also contains reports which provide market intelligence concerning timber cladding. The web site also provides a means for stakeholders in the supply chain to communicate and contact each other, thus facilitating the development of timber cladding supply chains.

The system has achieved positive feedback from those who have been briefed on its existence, even with requests to purchase it by name. The technologies encapsulated by the system are already actively being explored by timber manufacturers and suppliers.

Intellectual Property

The TDA does not hold any intellectual property rights over any of the parts of the system designed by TDA. However, partnering companies in the project such as Pryda, Uroxsys and Selleys should be consulted separately concerning their respective products developed in conjunction with the project. Contact details for relevant people within these companies is available in the "Flatline template quality installation manual" available at www.timber.net.au/flatline.

In general, it is concluded from the project that there is a growing market for lightweight cladding due to changing trends in housing architecture. Timber cladding has an opportunity to capture a segment of this market. The cladding system that has been developed from the project, known as "Flatline", specifically aims to take advantage of such trends and is primarily targeted at the mid to high end of the housing market.

It can be marketed by individual stakeholders under their own corporate names and marketing logos. In this context, the project has harnessed technologies from various areas required to provide a holistic and integrated system. This has had the added effect of fostering ties between component manufacturers, adhesive companies, timber manufacturers, timber importers and others, in improving timber product development beyond the scope of the original project brief.

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