

Hybrid Profiled Decking Innovation Engine 2019- 2020

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Task: Hybrid Deck

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Decking markets in Canada lack options of hybrid designs and are generally limited to smooth 5/4" or 2x6" of either pressure treated wood, cedar, tropical hardwoods or wood plastic composites. Profiled decking has been unsuccessful in entering the Canadian market on a large scale even though globally it is more prevalent. This report looks to leverage FPInnovations' expertise to identify opportunities to improve the stability, durability, performance and competitiveness of wood decking by combining profiling and treatment with additional non-wood materials. This information will be used to develop prototypes of novel wood-based decking products that would suit the needs of Canadian consumers as well as maintaining or expanding the solid wood decking market for Canadian producers. Six hybrid decking models were conceptualized to address market concerns about wood decking.

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1 OBJECTIVES

- To design concept hybrid decking to improve the competitiveness of wood decking

2 INTRODUCTION

Despite increased pressure from plastic and wood-plastic decking, Canadian wood decking has changed very little from standard 5/4" boards and 2x6" material that make up the majority of what is found on the market. The biggest change in the last decade has been the addition of brown colorants to preserved wood decking. These provide a more natural look and provide some additional protection against UV damage (Archer et al. 2013; Zhang and Ziobro 2013). They have also been shown to improve the weathering resistance of cedar (Stirling and Landry 2016). In international markets, variations of the standard deck board include profiled (ribbed, rippled or grooved) decking, hybrid decking products, and composite decking have made it into the market with success. FPIInnovations has previously attempted to introduce profiled decking to the North American market, but this had limited success.

It has been shown that ribbed decking does reduce the appearance and intensity of checking in some species (Cheng 2015) which would increase both appearance and functionality. However, the appearance is likely the market driver as profiled boards can be used to create novel designs. Profiling does require additional equipment and handling costs. A higher price would be needed to justify this expense.

The market share of plastic composite materials continues to increase at the expense of wood decking. In the northeastern US it now has a larger share than wood decking (Kavanaugh 2019). Although wood decking still maintains the majority in the rest of the U.S. and overall. The overall deck market is growing and expected to reach 7.1 Billion USD in 2020 with the non wood share expected to be 17.9% (Mendez 2016). However, plastic composites are increasing market share at a higher rate than wood decking. The improvements in processing of composite decking that reduce overall costs and create a more natural wood feeling in their products will be increasingly pressing for wood deck producers.

The higher cost of plastic composite decking gives wood decking producers the opportunity to improve the performance of their product while remaining cost competitive. Hybrid materials, that still use a core of solid wood, may help to address some of the market concerns about wood decking. This could include the opportunity to increase durability and sustainability, reduce checking, cupping and weathering, add anti-slip functionalities, and improve designability.

This report looks to leverage FPIInnovations' expertise to identify opportunities to improve the competitiveness of wood decking by developing multi-functional hybrid decks. This will be used to develop concepts for novel solid-wood decking products that would suit the needs of Canadian consumers and expand the solid wood decking market for Canadian producers.

3 STAFF

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4 CURRENT NORTH AMERICAN DECKING PRODUCTS

Research about current decking products in North America and product availability was done via web searches as well as some visits to local building material suppliers. Search terms included country names, decking, building supplies and deck coatings. In person research consisted of browsing the available materials at local suppliers.

Nominal 2"x6" and 5/4"x6" Preserved Wood or Naturally Durable Deck Boards

Deck boards most commonly available in North America are the nominal 5/4" or 2" by 6" or 2"x4" materials that are either naturally durable (e.g. western redcedar, redwood) or preservative treated softwoods. The most commonly used preservatives for decking in Canada are MCA, CA-B and ACQ. All of these systems are likely to meet consumer expectations for service life if treated to meet CSA-O80 standards (Morris et al. 2016; Stirling et al. 2016). Some copper-free systems (e.g. PTI, EL2) are also used in the United States. Cedar or naturally durable tropical hardwoods are popular due to their durability in combination with being preservative free. However, the premium cost, especially that of tropical hardwoods, limits their market share.

Nominal 1"x6" and 2"x6" Wood Plastic Composite (WPC) Deck Boards

Wood plastic composites have gained market share in decking products due to the perceived increase in durability and lower maintenance. In Canada several WPC options are available and are marketed as alternatives to traditional preservative treated decking. The price of the materials is not competitive with solid wood products but the inherent issues of wood products that aren't being addressed have led to more and more consumers moving to these alternative products at premium prices. Most home building suppliers will have WPC options available to their consumers giving options to those looking for them. Some concerns have been raised over dimensional stability in southern facing sun exposed decks where heat can cause warping in WPC boards. Some WPC are also prone to staining and even decay.

Other Materials

Aluminum, vinyl or other deck materials make up a small amount of the remaining deck material market share. They are expensive and mostly used in niche situations for unique looks or qualities.

5 CURRENT INTERNATIONAL DECKING PRODUCTS

International product availability and research was done via web searches. Searches were directed at large markets where wood decking products are produced, as well as China where many composites are produced. Search terms included the country name, decking, building supplies and deck coatings. Countries searched included UK, France, Germany, New Zealand, Australia, South Africa and China. Some additional countries were searched but due to language barriers it was not possible to efficiently retrieve the necessary information.

Nominal 2"x6" and 5/4"x6" Treated Timber or Naturally Durable Deck Boards

Profiled decking products are readily available in most European markets. It is generally tropical hardwoods, oak or softwood treated with copper-based preservatives. It is found easily in most building supply stores. Different variations are available from grooved, ribbed or more specialized end uses with boards that have artificial turf built in or rubberized material suitable for pool side or other unique applications. Preinstalled grip strips are also found in some markets and most markets have post installation grip solutions available. Smooth decking is still available as a common decking product in some international markets.

WPC

While available in most markets, WPCs are less prevalent than in north America. This could be due to the wide range of other profiled or optional wood deck types available to the consumer. Even WPCs tend to have profiling in the European market.

6 HYBRID DECK DESIGN CONCEPTS

We developed six different design concepts that may incorporate profiling and non-wood materials on solid or composite wood bases that may be additionally treated for anti-slip or more durable qualities allowing low maintenance (Figure 1).

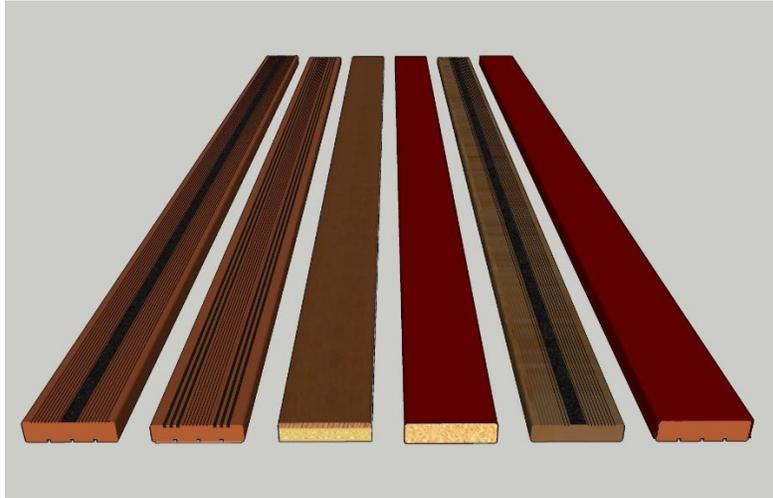
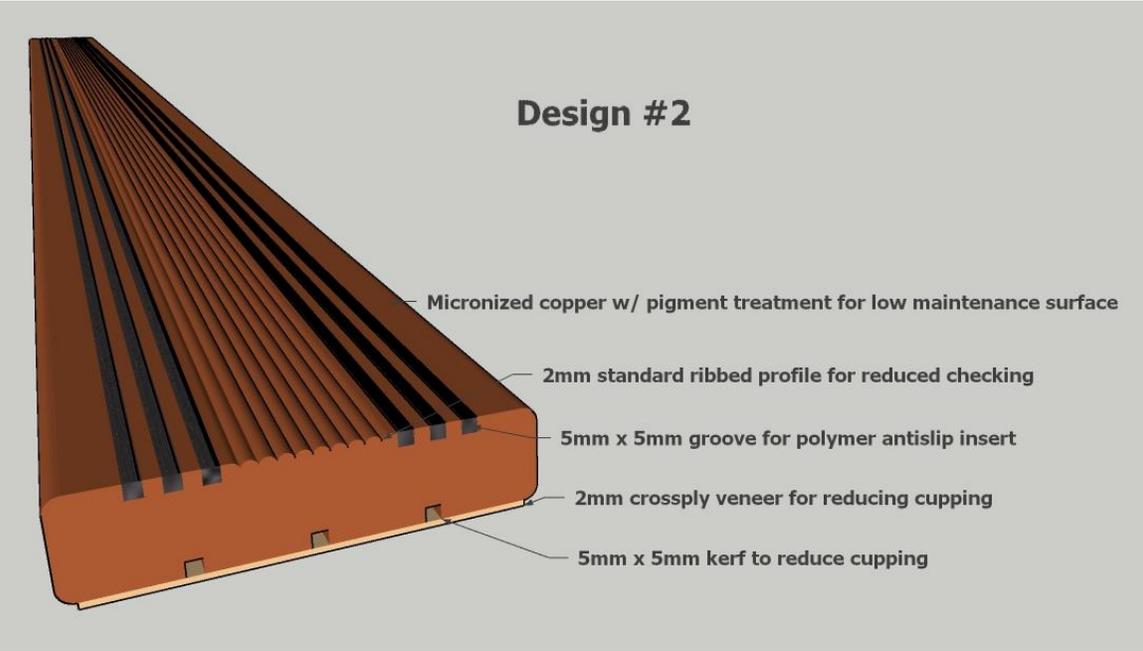
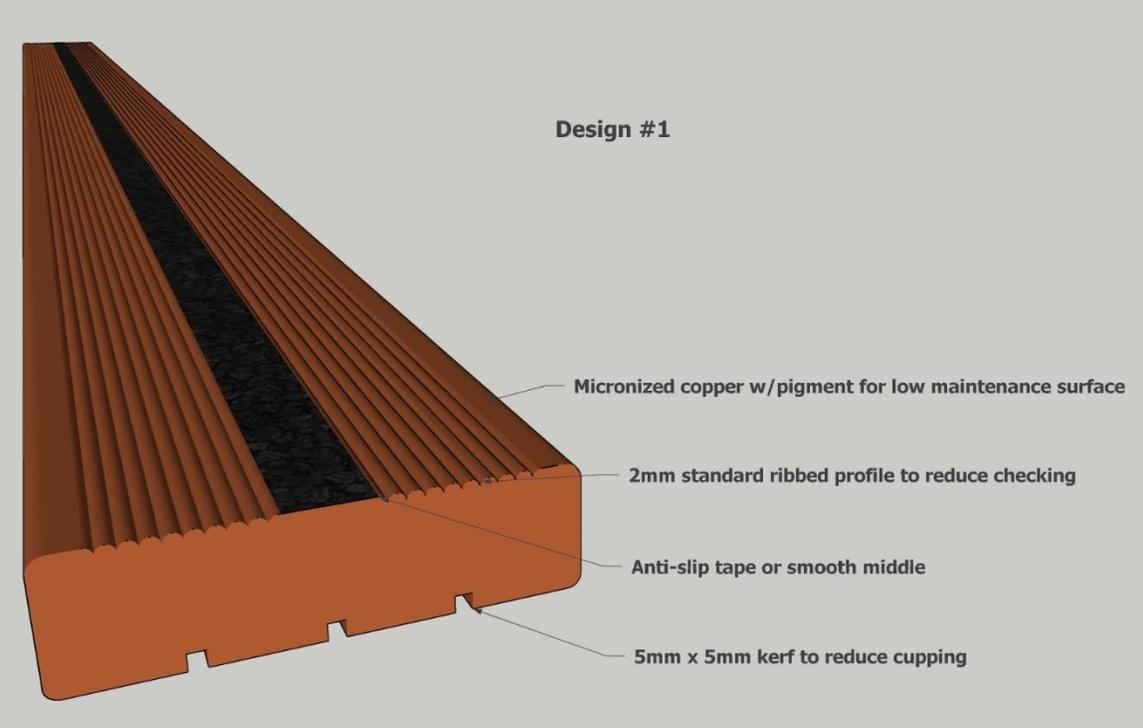
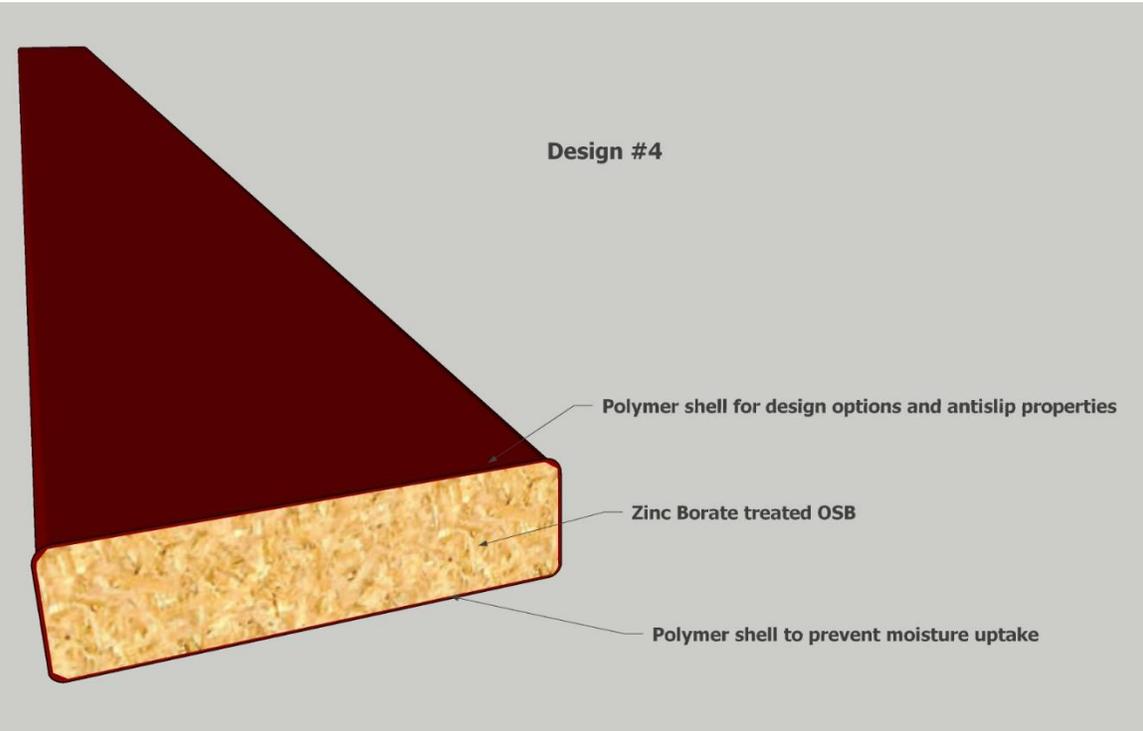
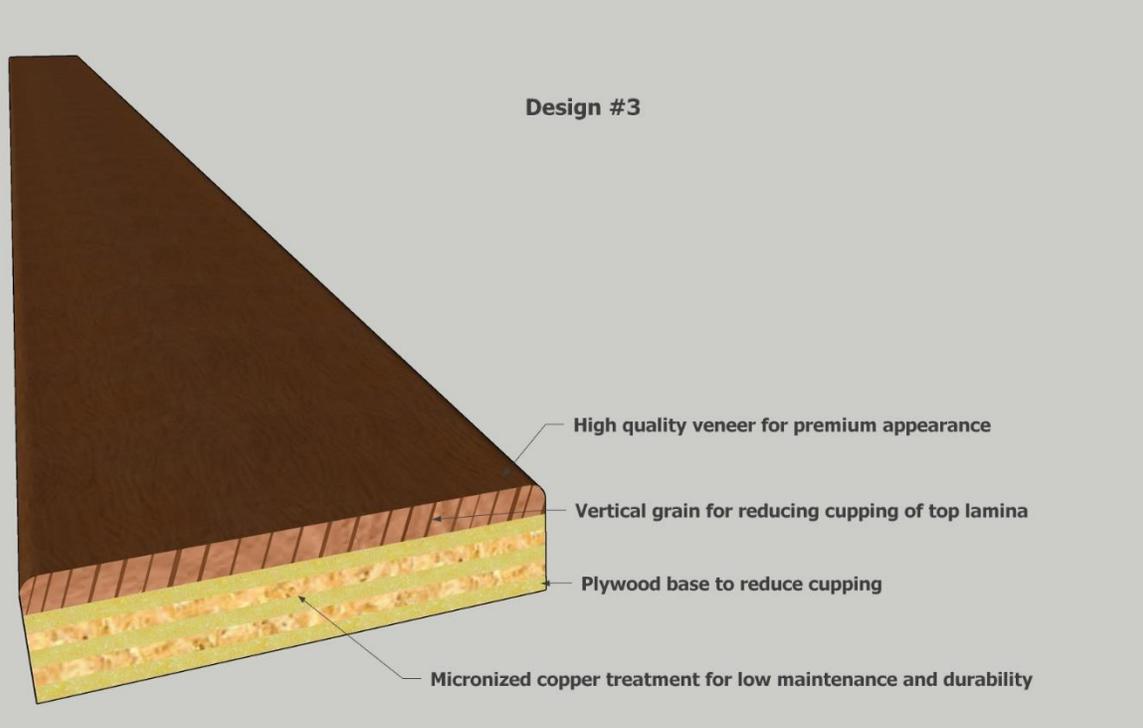


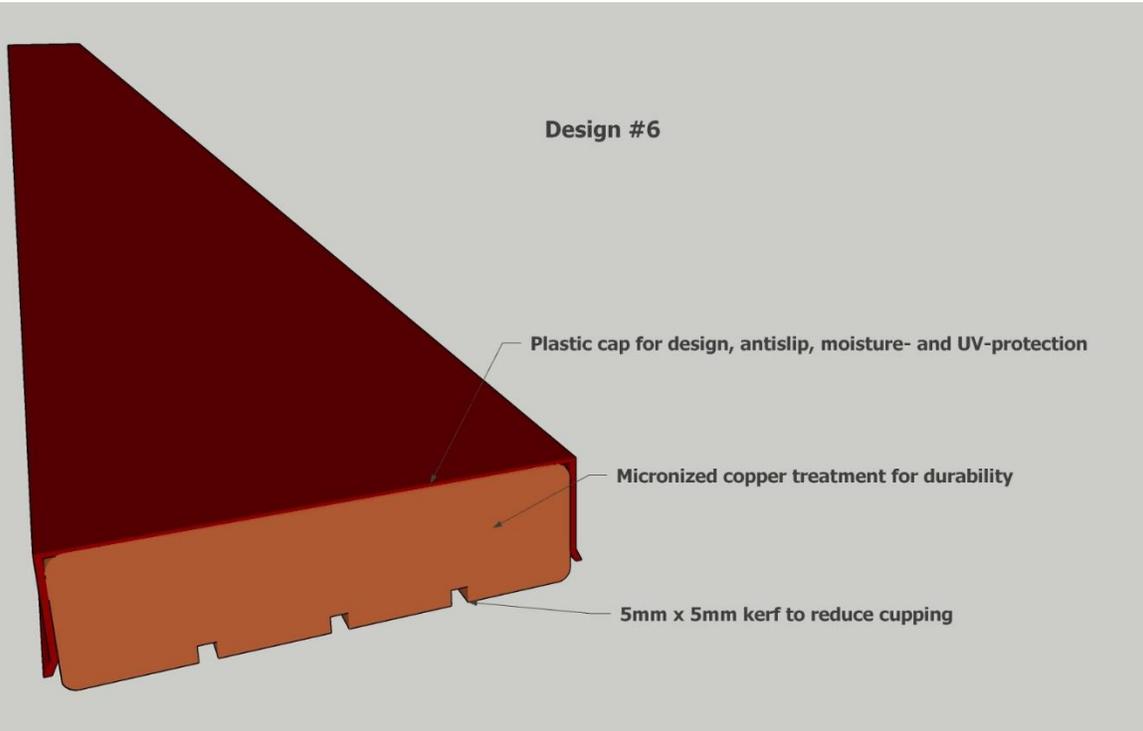
Figure 1 Concept deck designs lined up

Table 1 Design solutions and components summarized

Design#	Solutions					
	Size (mm)	Checking	Pre and post installation Cupping	Decay	Antislip	Color/UV
1	38 x 140	Ribbed outer smooth middle	Bottom kerf, 38mm thickness	Micronized Cu	Grip tape if necessary	Pigment
2	32 x 140	Ribbed middle + grooved outer	Bottom cross-ply+ Kerf +coating	Micronized Cu	Grip in grooves (RetroGrip®)	Pigment
3	32 x 140	10mm vertical grain Veneer	Plywood with vertical grain face	Micronized Cu	N/A	Pigment
4	32 x 140	Plastic Coating	OSB w/ZB	OSB w/ ZB	Grip in grooves (RetroGrip®)	Plastic Coating
5	32 x 140	Ribbed outer smooth middle	Bottom coating	Cedar	Grip tape if necessary	N/A
6	38 x 140	Plastic cap	Plastic cap, 38mm thickness	Micronized Cu	Plastic cover	Plastic cap







7 DISCUSSION

7.1 Cupping

Pre- and post-installation warping and cupping is a significant concern amongst consumers. Pre-selecting for non warped boards and installation to reduce cupping and warping in service is commonplace. Cupping and warping and the eventual checking of boards occurs due to internal forces that happen during wetting and drying of board (e.g. swelling at the bottom and shrinking at the top (Williams and Knaebe 1995). Flat sawn boards are more prone to cupping than quarter sawn boards, but to maximize recovery many deck boards are flat sawn. For flat sawn material, alternative solutions to cupping are needed. Addressing the issue of cupping in service may also have an impact in the frequency and intensity of check formation and solve multiple issues with one solution.

Due to the large forces involved when wood cups, solving cupping will need an equally strong counter action. Kerfing has worked for reducing cupping but sometimes is not enough to reduce the stresses involved.

Design 2 implements a reduction in forces with kerfing but also applies a cross lamination along the board to further resist the cupping forces. A bottom coating would also be applied to minimize moisture uptake on the bottom side of the board. A multifaceted approach to cupping seems justified as the forces involved are so strong as well as the impact it has on deck appearance. This is likely an expensive solution with the additional handling and application of a lamina, but necessary to meet consumer demands and stay competitive with WPCs and tropical hardwoods.

Design 3 uses plywood which shouldn't cup due to the cross-ply structure. The top lamina should be a vertical grain board which is less likely to have the stresses causing cupping.

Design 4 uses OSB which by nature won't cup. A shell casing will also protect the outside from moisture. Protection of the cut ends must be taken into account to reduce moisture related swelling.

Designs 1, 5 and 6 take a single solution approach of either kerfing or coating or encasing to reduce the stresses that cause cupping. These are more economical approaches and while they may reduce cupping in some boards, are not likely to prevent cupping in all boards.

7.2 Checking

Checking performance is also a large factor in consumer expectations for decking. Profiling has shown to significantly reduce the number and sizes of checking in Pacific Silver fir (Cheng 2017) however this also increased cupping, which reinforces the need for a multifaceted approach to solving deck appearance issues. Two mm tall ribbed profiling was also the most effective for reducing checking vs ripple or shorter ribbed profiles. Therefore, we would recommend the two mm ribbed profiling. For designs 1, 2 and 5, this would be applied. Design 3 will use premium

quality flat grain veneer which should help minimize checking. Design 4 will be encased in plastic and therefore won't have a checking problem. Design 6 completely covers the board surface and would not have any checking issues.

7.3 Anti-slip Features

Many products are currently available for anti-slip features. Adhesive or mechanically fastened strips are frequently applied to stairs or slippery areas for increased traction. They can range from \$1-3 per linear foot. The advantage of applying an anti-slip product after installation is that it can be used only in areas where necessary rather than broadly applied. While factory applied grip strips can reduce the cost vs post installation (only 35% over non slip boards). The overall cost increases due to using it in unnecessary areas may hinder acceptance. Therefore, options for with and without anti-slip features may be needed. It is recommended to use adhesives to attach anti-slip features rather than mechanical fastening due to durability issues that may arise from top screwing.

Designs 1 and 5 have smooth middles that would allow for a grip tape to be applied post installation where necessary. Design 2 will have 5mm x 5mm grooves in which preinstallation grip or post installation grips can be applied. Having the option to self install available to consumers is recommended. Design 3 will be a smooth surface board so any anti-slip product would need to be applied to the surface after installation. Designs 4 and 6 would need to have anti-slip features imbedded on the product surface.

7.4 Decay and UV resistance

Micronized copper formulations are readily available in the Canadian market. UV protection from the copper preservative can increase the service life of the deck keeping the surface from greying. The addition of pigment to the micronized copper solution is also already applied broadly to appeal to consumer preference. The addition of pigment can add the tone of colour of homeowner preference as well as reduce the need for staining and reduce overall maintenance.

Designs 1-3 and 6 would employ a micronized copper system to protect against decay and UV. Design 4 relies on zinc borate within the OSB and the shell for protection. Design 5 will rely on natural heartwood extractives to protect against decay and then homeowners either accept the natural greying of the deck or be prepared to stain as required.

For all concept designs deck fastening for hybrid decking should be flexible as so it can be done like any other decking. However, it is recommended that decks be fastened by systems that do not screw down through the top of the board. It has been shown that boards fastened by screwing from the top have much higher incidents of decay compared to other fastening methods (Kutnik 2019). Ultimately this would imply using a hidden fastener system. In some cases, the designs described here may need additional side grooves to accommodate such fastener systems.

We also considered how deck construction may have an impact on decay development. This included concepts where deck boards are designed for water drainage. While it has been shown that if boards are designed for drainage it can increase service life (Kutnik 2019), the overall impact of the look and functionality of the deck would also be impacted. It was concluded that if the cupping issue is addressed to eliminate water trapping, and decks are built with a slight incline to allow for water drainage then the durability issues by design would be effectively managed.

7.5 Maintenance

Deck maintenance is considered a burden by many deck owners. Improvements could be made by reducing the frequency of required maintenance and making the maintenance tasks quicker and easier to perform. Wood should aim to be as low maintenance as WPCs. This would likely entail an annual scrubbing and periodic sweeping. The major need for wood deck maintenance comes from refinishing. The need to re-stain every 2-3 years is a major drawback for many consumers. With UV protection from the copper-based treatments, the wood fibres fray less and create a smoother surface which is less likely to retain dirt. In a comparative study, decks treated with a copper-based preservative were more easily cleaned than those that were untreated or treated with a copper-free system (Stirling and Wong 2018).

An MCA plus pigment solution is effective and has already been adopted by the market. Combining this with improved design features should further reduce the need for maintenance. MCA plus pigment is implemented in Designs 1, 2, 3 and 6. Cedar in design 5 will have maintenance requirements similar to untreated wood. Staining may be required as necessary to meet homeowner expectations. Design 4 and 6 will have surfaces like WPC's and would be maintained similarly.

Deck coatings were investigated but ultimately decided against as it adds a component of maintenance that is otherwise addressed with plastic shells or micronized copper with pigment treatment. Some coatings could be applied to the bottom of deck boards to address moisture issues from the bottom of the deck. This is shown in design 5. Since the underside isn't exposed to UV or normal wear and tear it would not need re-applying as routine maintenance.

7.6 Designability

This feature is intended to give architects and homeowners the ability to create more individualized deck patterns and designs. Making it possible to mix and match features would be ideal. Designs 1-5 can be used creatively by deck builders to create as they would with conventional deck boards. The textures from profiling would add depth to the possibilities.

The addition of a plastic cover such as design 6 is a way to protect and provide low maintenance aspects and increased durability sought after in a deck product. It also allows use of the same boards currently produced for the decking market. Depending on available colours and textures, it could create many unique design features after installation of the deck is completed. It also allows for design to be changed over the life of the deck. Removable deck skins could be used to

showcase art or commercial branding. The complete coverage of the surface of the deck board in design 6 may also allow the use of lower grade wood.

8 CONCLUSION

- Six hybrid decking concepts were developed to address wood decking performance issues

9 RECOMMENDATIONS

- Consider development of prototypes and costing for hybrid deck designs to address the following compendium action items
 - Improve significantly the wood stability, durability performance of wood with the use of natural green products for interior and exterior uses
 - Improve Value from low grade wood and underutilized species
- Intellectual property potentially associated these deck designs has not been reviewed. This would need to be completed prior to further development.

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APPENDIX - SOURCES

Deck Boards

Canada

<https://www.homedepot.ca/en/home/categories/building-materials/decking/deck-boards.html>

<https://www.standardbuildingsupplies.ca/products/building-products/>

<https://www.rona.ca/en/building-supplies/decking>

USA

<https://www.fiberondecking.com/compare-fiberon/wood-vs-composite-deck>

<https://www.menards.com/main/building-materials/lumber-boards/treated-wood-products/treated-boards-decking-lumber-timbers/2-x-6-2-prime-ground-contact-ac2-reg-tongue-and-groove-treated/1111163/p-1444422770515-c-13125.htm?tid=4933259086786502248&ipos=36>

UK

<https://www.tdca.org.uk/timber-decking/>

Timber Decking | Decking Boards and Wood Decking Information - TDCA

Timber decking is increasingly the material of choice for stylish or contemporary gardens. Timber has inherent warmth and beauty which enhances its surroundings; making the atmosphere somehow softer, calmer.

www.tdca.org.uk

<https://www.wickes.co.uk/Products/Gardens/Decking/Timber-Deckboards/c/1000707>

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<https://www.deckingsupplies.co.uk/>

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France

<https://www.mr-bricolage.fr/jardin/amenager-le-jardin/terrasses-et-sols/dalles-et-lames/lames-de-terrasse-bois.html?magasin=plouguerneau>

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South Africa

https://leroymerlin.co.za/building-materials?gclid=Cj0KCQjwu6fzBRC6ARIsAJUwa2SlqcwQGOx85Af5xkwX4DIH49Fey6cPn7VMftjFGJXy-f_sX8WU6JAaAmjkEALw_wcB

Germany

<https://www.bauhaus.info/suche/produkte?text=die%20terrasse&redirect=false>

Australia

<https://www.bunnings.com.au/our-range/building-hardware/decking/treated-pine-decking>

Treated Pine Decking Available At Bunnings Warehouse

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www.bunnings.com.au

New Zealand

<https://www.placemakers.co.nz/products/landscaping/decking/timber-decking/>

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www.placemakers.co.nz

China

https://www.alibaba.com/products/F0/deck_board/--CN-----G-----COUNTRY-CN/2.html?spm=a2700.7724857.6.1.6a8f7d2dIlleJDC

Deck Board-Deck Board Manufacturers, Suppliers and Exporters on Alibaba.com Engineered Flooring

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Sealants, Oils and Polymer Coatings

<http://www.dtep.com/woodoil.htm>

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www.dtep.com

<https://seal-once.com/water-based-concrete-sealers-wood-stains/nano-particle-wood-sealer-technology/>

<https://www.ronseal.com/for-garden/decking/decking-oil/decking-oil/>

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<https://www.spraysolutions.ca/extend-life-wooden-deck-industrial-polyurea-coatings/>

<https://osmo.ca/products/exterior-coatings/decking/>



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