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**Material Intelligence:
An Overview of New Materials for Manufacturers**

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INTRODUCTION

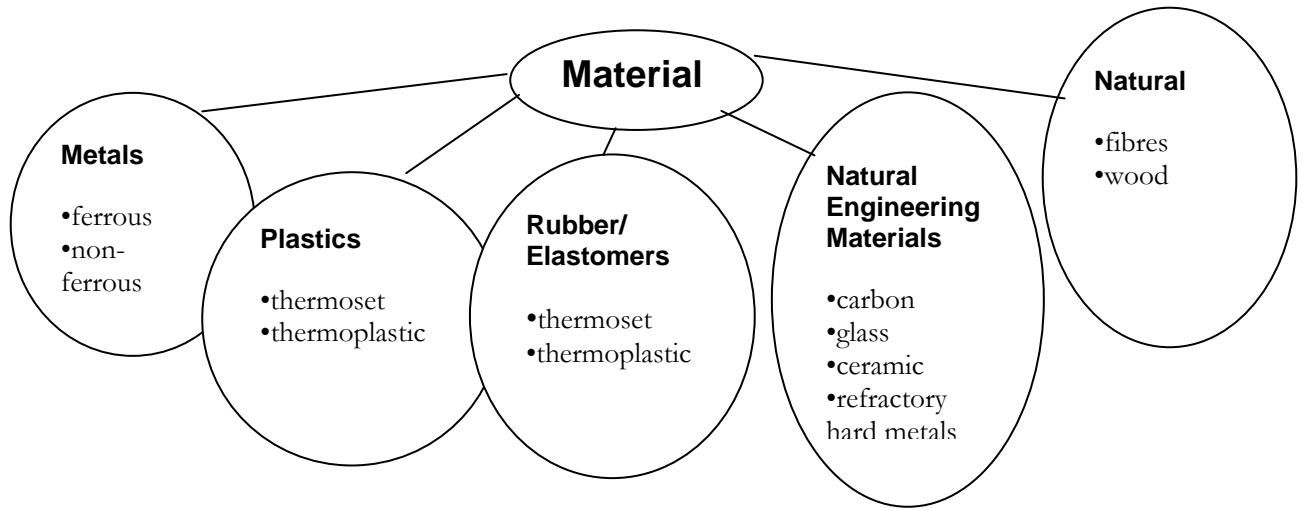
Materials are the core of the built environment: everything except nature is based on a material of some kind. Manufacturers make those materials into products that are, in turn made into the built environment that we rely on every day. In this era of seemingly endless products, materials serve a critical purpose in helping to differentiate one product from another. By simply changing the material of virtually any product, without changing any other aspect of its design, it can be changed from a commodity product into a luxury good (or vice versa). By choosing the right material, a manufacturer can make this transformation without altering the unit cost of the product. Therefore, material knowledge is extremely powerful.

MATERIAL SCIENCE

Humans have been using materials since the beginning of civilization. In the beginning humans used only natural materials like stone, clay, skins and wood. Eventually it was discovered that materials could be manipulated and changed, clay could be baked and made into water proof vessels, metals could be alloyed and made into tools and weapons and so on. Bricks for building were made out of mud until our ancestors realized that by adding straw to the mud meant they lasted longer. By mixing two materials with different properties one developed a third based on a combination of those properties, and thus the first composite material was made.

In the early 1900's, we gained atomistic understanding which led to the sciences of physics and chemistry, and finally to the relationship between the properties of a material and its microstructure. This is the domain of **Materials Science** whose aim is to understand materials on an atomic level so that new materials with desired properties can be created. The knowledge generated by the field of materials science, that is, of materials and their properties, is mainly used by industry to develop new and improved products.

Materials can be broken down into five major categories; metals, plastics, rubbers/elastomers, natural engineering materials and natural materials. The diagram below breaks these down further.



Metals

The use of metals in a product can add to both its aesthetic and structural integrity. Metal is often used for its strength, ductile or conductive properties. It also adds value through its look and feel made possible through opaque and reflective surfaces. In order to achieve specific properties, metals are formulated into alloys, which are compositions of two or more chemical elements with at least one being metal. Metal can be formed through a variety of processes each offering specific benefits and restrictions relating to cost, lead time, effect on performance, perception of quality and durability. Standard methods for processing metals include; casting, roll forming, stamping, extruding, forging, spinning or hydro-forming. Some common methods for finishing metals are; anodizing, electrostatic painting, enameling, powder-coating, and screen printing. Joining metal usually involves welding but adhesive gluing is also possible. When metal to non-metal joints are needed, mechanical fasteners are often used. However, special adhesives have been developed to adhere metal to wood and these are being used more frequently in office furniture. Ferrous metals (containing iron) such as stainless steel or cast steel have lower melting points and are more conductive, that is they quickly conduct heat away from themselves which is why they are cold to the touch. Nonferrous metals, such as aluminum and copper tend to have even lower melting points and are less conductive.

Plastics

Plastics are made from a wide range of synthetic or semi-synthetic organic solids. There are two types of plastics; thermoplastic such as nylon and polystyrene which soften and melt when heated, and thermoset plastics such as melamine and polyester which do not melt when heated. Plastics are typically easy to form, are lightweight, and resist corrosion, though their properties vary widely. They offer amazing aesthetic range and can be coloured and finished to almost any look one could imagine. There are a huge number of methods used to shape plastic but a few of the more common methods are; injection molding, casting, compression molding, extrusion, thermoforming and transfer molding. Often plastics do not require a finish but when they do it is often electroplated or painted. Joining methods for

plastic include; adhesive bonding, ultrasonic welding mechanical fasteners and molded in 'snaps'.

Glass

Glass components are very common in wood products such as furniture and doors. The effect of transparency and translucency that glass offers makes it invaluable. It is also relatively strong and impervious. Flat glass for windows and similar applications is formed by the 'float glass' process developed in the 1950's. Contemporary manufacturing of glass is focused on refining traditional processes and glass formulations for high-tech uses. After glass has been formed it can have a variety of secondary processes applied to it to achieve a wide variety of characteristics. For example it can be annealed, tempered, coated or decorated.

Ceramics

Ceramics traditionally refers to clay, but more broadly refers to any nonmetallic inorganic (not plant or animal) material. Ceramic materials are strong and light but can be brittle. Ceramics are a continually evolving materials that are commonly used in the manufacturing of consumer, commercial and architectural products. Standard clay processing involves; bisque firing, dry pressing, extruding, firing and glazing. Slip-casting is a method used for high volume production. Contemporary manufacturing of ceramics is focused on refining traditional processes and developing new processes and clay formulations for high-tech use.

Elastomers

An elastomer is a polymer with the property of viscoelasticity. Elastomers are often referred to as rubber and are characterized by their relative flexibility. Elastomers are usually thermoset materials (do not melt) but may also be thermoplastic (softened by heat). Elastomers are used extensively in consumer and commercial applications.

MATERIAL SCIENCE TODAY

Radical materials advances can drive the creation of new products or even new industries, as was the case when plastic-wood composites were developed. However, materials knowledge is also used to make incremental improvements and troubleshoot issues with currently used materials. An example of this is a current version of a high pressure laminate (HPL) that has the same coloured core as the surface. In some applications, the standard black core is undesirable and this small innovation provides a solution for a particular market need.

Product innovation does not always emerge from new materials or technologies though, it can also develop from older ideas that continue to hold their own in the current environment. Consider thermally modified wood (heat-treated wood for outdoor applications), the heating/burning of wood was done in early Aztek woodworking. They soaked wood in water and then repeatedly heated it in fires until all the moisture was removed and a very durable material was created. This 'technology' was refined by the Finnish a decade ago and is currently entering the North American market.

Material science (old or new) is regarded as one of the richest sources of innovation for manufacturers. In the past, many new materials were developed for special purposes such as aerospace or military and then adopted into use for consumer products. Memory foam is one such product, it was originally developed for astronauts to delay the physical fatigue experienced during space flight, but it is now a popular material for mattresses and sofas.¹ While the bulk of new material development at the turn of the century was the result of the steady progress of technology, the primary motivator is now environmental concerns.

Virtually every material, product, and building system manufacturer is developing new technologies and revising existing ones in order to accommodate the recent surge of interest in environmental awareness and “green building”. As the depletion of material resources continues, product manufacturers must be more creative about how to optimize raw materials and utilize waste. Conventional materials are enhanced with augmented dimensionality for additional strength and elongated spans, and exotic new fibers and composites exhibit increased strength-to-weight ratios.² The more frequent use of waste materials in manufacturing new products has helped alter the perception of recycling where recycled products are no longer viewed as having downgraded value. In many cases, products diverted from the waste stream are converted into uses that exhibit greater value than their original applications. Rapidly renewable materials are replacing non-renewable sources, and rapid-growth plants are being scrutinized for their value as fuels or other material replacements.

GENERAL MATERIALS TRENDS

The following eight trends indicate what is currently driving new material science research in the world today.

Green Materials

The single largest driver of new material science is sustainability. Alternative-energy technologies, resource-conservation measures, and pollution-reduction strategies are transforming the way buildings and products are made.³ The ultimate in green materials are those that adhere to the cradle to cradle philosophy. This means that the material can be used again and again with no adverse effect on the environment. Bio-based materials are being explored to that end. There are already upholstery fabrics and office chairs that pass Cradle to Cradle Certification. Green materials such as no-added formaldehyde MDF and particle board are being assimilated into the market proving that green solutions do not have to be financially prohibitive. The number of materials made from recycled waste is increasing. Examples include paper countertops which are made from post-consumer recycled paper saturated with resin and then heated and compressed. There are many other countertop materials made from recycled materials and their success in the market indicates that these products are durable, aesthetically appealing, and meet a consumer need.

Materials as Fashion

An entire section of new materials are being developed simply for their aesthetic or psychological effect. So, in addition to providing technical functionality, some materials are created just out of the desire to create product personality. For example translucent materials impart a luminous, enigmatic quality to a product or space. The role of these materials, and the end products they create, is particularly relevant to those manufacturers making products that are subject to high aesthetic discrimination such as furniture, cabinetry, flooring, doors and windows and so on. New materials are being used to imbue a product with extravagance, imagination, intrigue and symbolism. This is in relation to a broader trend in which consumers are looking to bring art into everyday life.

Security

A new motivator in new material science is being driven by global political and economic instability. Natural/human-made disasters such as the Asian Tsunami, Hurricane Katrina in the US and the floods in Pakistan and Australia caused a sense of fear and vulnerability. 9/11, the wars in Iraq and Afghanistan, and continued turbulence in the Middle East have also contributed to this sense of vulnerability. Together they have resulted in a recent increase in the number of security-related products such as building panels that provide increased resistance against storms and ballistic loads and those that include sophisticated electronic detection and alert systems.

Modern

Architectural products such as furniture, cabinetry and millwork, can be roughly divided into modern and traditional style genres. Style genres are a fundamental influence on material trends. Modern or contemporary products represent a smaller but rapidly growing sector of the overall North American market. Traditional styles represent the larger, mainstream section of the market. In terms of material innovations, modern products/markets are natural leaders because modern design is based on the use of new materials and processes. This explains why there tends to be a higher ratio of products that use new or mixed materials in a modern style rather than traditional. Traditional styled products/markets are, by their nature replicas or reproductions of the past and as a result tend to rely on traditional materials or at least those that 'look' like traditional materials.

Digital Technology

Materials are becoming aligned with technological processes and these new interfaces are slowly beginning to define materials rather than being shaped by them. The advent of digital fabrication technologies allows for the design and production of materials and products that would otherwise be very difficult or even impossible to realize. It has reintroduced the detailed individual artistry and sophisticated refinement of the craftsman. This technology's influence on materials and products can be readily seen in today's interiors. One of the outcomes of



computer driven fabrication is a renewed interest in ornament and pattern making. Features like complex curves, intricate cut-outs and carvings, and products that involve high complexity or precision are being seen more often. Rapid prototyping is another technology that is influencing new material development. Rapid prototyping takes 3D designs from CAD and transforms them quickly into a physical prototype. There are a variety of technologies used but stereolithography is the most common. Think of a 3D printer that prints in resin.

Biomimicry

Biomimicry is defined by the person who coined the term, scientist Janine Benyus, as ‘the process of learning from and then emulating life’s genius’. There is a huge interest in taking inspiration from natural phenomenon and many new materials have been developed in this manner. For example, a professor from Oregon State University, Kaichang Li, noticed the impressive staying power mussels had that allowed them to cling to their underwater homes in currents that swept most other small animals out to sea.⁴ This observation led to research on waterproof adhesives with a view to replacing traditional, carcinogenic formaldehyde-based adhesives. It was discovered that the strength of the mussels’ grip relies on secreted proteins called Byssal threads. Dr, Li created a mimetic adhesive made from soy proteins which outperforms formaldehyde-based alternatives and is comparable in cost. This adhesive has been licensed to Columbia Forest Products who make a variety of glued wood products. In addition to solving tricky functional problems, biomimicry is being used to inspire aesthetic decisions. For example, a carpet manufacturer created a carpet tile based on the random pattern of a forest floor.

Nanotechnology

Physicist Richard Feynman posited the notion of nanotechnology in 1959.⁵ He suggested that if the movement of small parts of materials (to the order of ten to a hundred atoms) could be controlled, it would be possible to completely change the properties and performance of things. This is akin to the way our skin heals when cut. Nanomaterials include all nanosized materials, from engineered nanoparticles to those that exist in nature. Over the past decade there have been incredible advances in certain industries using nanotechnologies. One example is in the textile industry which has successfully created stain resistant fabrics achieved through molecular alteration of fibres. Another example is nanocellulose which is a pseudo-plastic made from wood-based pulp fibres. The resulting material can be used in food as a thickener, in cosmetics, in paper and textiles, and as food packaging.

Intelligent Materials




Otherwise known as ‘Smart’ materials these materials are designed to be responsive to external stimuli such as stress, temperature, moisture, PH, electric or magnetic fields. Their properties such as shape, colour, stiffness or viscosity can be changed significantly in a predictable or controllable manner in response to their environment. An example of an intelligent material is liquid crystal glass which changes from transparent to opaque upon











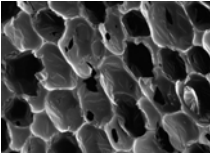



application of a current, it is like being able to instantly close the blinds with a flick of a switch. There is also thermochromic glazing that changes transparency in response to ambient temperatures. Even newer research is working on electroluminescent polymers that will make windows capture light during the day and then emit light at night, reducing the need to turn on the lights. The general idea of smart materials is to make materials that are both user-friendly and environmentally friendly.



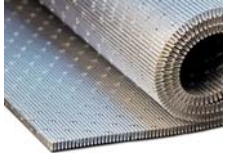
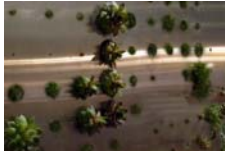

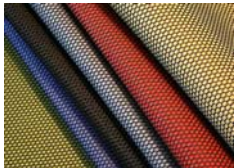
NEW MATERIALS OF INTEREST







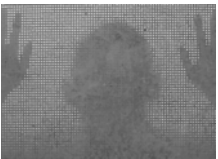
Covering the entire world of innovative products is beyond the scope of this study so the following new materials were selected based on their potential use in products such as furniture, cabinetry, millwork and outdoor products. They are presented here to give the reader inspiration for new product development directions.


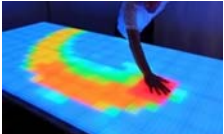

Bio-Materials	
	<p>Richlite panels are extremely dense, strong and stable and are made of layered craft paper. This material was originally developed for the aerospace industry as tooling, but has been used in a variety of architectural applications and even for outdoor skate ramp surfaces. Richlite resists scratching, staining and heat damage and will not harbor bacteria or pests. It is through-coloured and develops a deep patina over time.</p> <p>Contact: Rainier Richlite Corporation</p>
	<p>Maplex is an environmentally responsible, high-density fibreboard. There are two types of Maplex, one with twice the bending and tensile strengths of birch plywood of the same thickness and the other one that is ideal for forming and bending into smooth complex curves. Maplex can be machined, bent, rolled, formed, punched etc. It is made of thin plies of softwood fibers that are processed without bleach, binders, formaldehyde or other off-gassing chemicals.</p> <p>Contact: Maplex</p>
	<p>Fortis Arbor wood mosaics are made by shaping and finishing exotic hardwoods made from plantation-grown lumber. The tiles are handcrafted from solid bamboo, teak and rosewood. Can be used on walls, countertops, backsplashes, etc. Intallation requires Fortis Arbor grout.</p> <p>Contact: Flux Studios, Inc.</p>

	<p>BL Special is a composite panel comprised of wood veneers and a proprietary substrate. It was developed to overcome limitations presented by conventional composite panels when modified by laser cutting. The material may be easily folded along scored lines and is designed for the assembly of complex geometric structures.</p> <p>Contact: Ableflex</p>
	<p>BAMbOO panels are made by casting bamboo section in translucent resins. The diagonally-cut bamboo sections may be open or filled with a different color resin. These panels offer acoustic performance.</p> <p>Contact: LAMA Concept</p>
	<p>Kebony is a high performance wood that is modified by a process called Kebonization, which is an environmentally friendly procedure that enhances the properties of wood using biowaste from the sugar industry. Kebonization results in the wood being denser, stiffer, more stable and harder than untreated wood.</p> <p>Contact: Kebony ASA</p>
	<p>Bendywood is solid hardwood that can easily be bent while cold and dry to a radius of ten times its thickness. Thin sections can be bent by hand and thicker sections with the application of sufficient force. Handrails can be bent into shape or table legs can be profiled and then glued into place.</p> <p>Contact: Candidus Prugger Sas</p>
	<p>Luminate combines translucent plastic and wood strips in a rigid panel format, allowing light to filter through a material used for applications that would usually require an opaque surface. The material is a modified acrylic adhered to selected exotic timbers with a proprietary fusion process.</p> <p>Contact: Ambro Australia Pty. Ltd.</p>
	<p>Accoya is a high performance solid wood that is modified by a proprietary process called acetylation. This technique results in class 1 durability, increased stability, mold and insect resistance, UV degradation resistance and reduced thermal conductivity. The wood is sourced from sustainable forests. Accoya is appropriate for outdoor applications.</p> <p>Contact: Titan Wood Limited</p>

	<p>Arboform is a thermoplastic material made out of lignin and other natural fibres. It can be injection molded like plastic and possesses the same material properties as wood it is often called 'liquid wood'. Contact: Tecnar GmbH</p>
<p>Polymers</p>	
	<p>Durat™ is a polyester based solid surface material which contains about 30% of recycled material and is 100% recyclable. It is cast into sheets and can be fabricated using woodworking tools into seamless surfaces. It is very resistant to wear, humidity and various kinds of chemicals. It can be used for furniture, millwork and countertops. Contact: Durat</p>
	<p>Bio-/based Foams are flexible and rigid polyurethane foams from soybean oil polyols. The advantage of these foams is that they can replace petroleum-based materials in mattresses and upholstered furniture. Contact: Center for Composite Materials, University of Delaware.</p>
	<p>Scintilla is an acrylic-based solid surfacing material that is transparent and translucent, with acrylic chips embedded into the material to create unique optical effects. They can be used for flooring, walls, wall panels, doors and furniture. Contact: SensiTile Systems</p>
	<p>Trespa Meteoron is an extremely weather resistant panel, unaffected by sunlight, rain or moisture. The phenolic-based material is also highly impact resistant and hard to deface. There is no need to finish or cover the cut edges and standard woodworking tools can be used to fabricate. Contact: Trespa International BV</p>
	<p>100 Percent is a material designed to have a minimal environmental footprint. Made entirely from postconsumer recycled high-density polyethylene (HDPE), it is waste transformed into engineered panels. These panels are UV stable and ideally suited for high-wear areas. Contact: 3form</p>

	<p>Tencil® is a foam for mattresses and upholstery that incorporates a climate-regulating powder. This means that moisture released is quickly wicked away and released keeping the person in contact with it comfortable.</p> <p>Contact: Lenzing Fibres</p>
<p>Metals</p>	
	<p>Intaglio composites has developed a process to permanently engrave images or text into aluminum. Photo-Engraved Aluminum is relatively inexpensive and can be in interior and exterior applications. It is also graffiti resistant.</p> <p>Contact: Intaglio Composites</p>
	<p>Aero consists of tightly corrugated anodized aluminum sheets that are flexible and formable. Crisp, exacting folds characterize each sheet and cast deep shadows that contribute to the dimensionality of the material. Aero is for interior applications and can be used to create geometric compositions of fluid curves. It has a matte silver anodized finish.</p> <p>Contact: Forms+Surfaces</p>
	<p>Live Within Skin is a steel wall comprised of layers of lightweight plant-growth medium. It can be mixed with other materials or be a stand-alone product as a vertical garden. It can be used inside and out.</p> <p>Contact: Greenmeme</p>
<p>Fibre</p>	
	<p>Gore Tenara KT is a three-dimensional moldable fabric made from 100 percent knitted polytetrafluoroethylene (PTFE). This fabric is immune to UV rays and is weather resistant, elastic and durable.</p> <p>Contact: W.L. Gore & Associates GmbH</p>
	<p>Spacer is a high-tech upholstery fabric with a three-dimensional look. Visually it appears to be three separate fabrics layered. The look is achieved by a complex knitting process allowing all layers to be knitted at once, which makes it incredibly strong. This makes the fabric thick and comfortable to sit on.</p> <p>Contact: JhaneBarnes Textiles</p>

Glass	
	<p>Stones is made from unused tempered glass from construction sites. It is remanufactured into sheets and can be used anywhere tempered glass would be used.</p> <p>Contact: Joel Berman Glass Studios (Canada)</p>
	<p>3form glass is based on a patent-pending liquid lamination technology that allows for even distribution of object throughout the glass. It has clean edges so frameless applications are possible.</p> <p>Contact: 3form</p>
	<p>Researchers at the Fraunhofer Institute and the Darmstadt University have developed a new type of soundproof window. This is particularly appropriate for extremely noisy environments like airports or loud entertainment centres. This should be on the market in about four years.</p> <p>Contact: The Fraunhofer Institute</p>
	<p>Fusionstone is ultra-clear glass permanently fused to stone slabs to achieve superior surface protection that plain stone. This is important where natural and chemical substances would normally get into more porous surfaces. LED lighting can also be integrated into Fushionstone for additional aesthetic enhancement.</p> <p>Contact: Architectural Systems, Inc.</p>
	<p>LightBlocks are a patented, durable, light transmitting medium used for furniture, doors, lighting fixtures and flooring. There is a matte finish and a fingerprint-block coating added. Colour is completely custom with no extra cost. It can also be ordered as fire rated, LEED certified and bulletproof.</p> <p>Contact: MB Wellington Studio, Inc.</p>
Concrete	
	<p>Creacrete is a concrete-based material that is highly dense and compact and can be used to make thin-walled objects with glossy surfaces. This makes is an alternative material for ceramics.</p> <p>Contact: AlexaLixfeld Design GmbH</p>
	<p>Pixel Panels are one manifestation of the broader family of materials called translucent concrete. Pixel panels use concrete as a binder within which a uniform array of polymers is added to provide translucency at a given viewing distance.</p> <p>Contact: BPZ</p>

	<p>Durisol concrete forms are made from a proprietary cement-bonded wood fiber material. It is made of recycled waste wood and Portland cement. The resulting concrete forms are lightweight and durable. They do not rot or decay. Contact: Durisol Build</p>
Miscellaneous	
	<p>Sensacell is a motion-sensitive panel. Colored LED cells light up in response to motion above the panel. The modular system provides touch-free proximity sensing and comes in various panels sizes. They can be used in furniture, millwork or interiors. Contact: Sensacell</p>
	<p>EnerGlo is a waterproof breathable glow-in-the-dark coating that can be applied to most woven fabrics. EnerGlo coated fabrics can be used for a range of products from sportswear to awnings. It has a 3-6 hour glow time. Contact: EnerGlo (Canada)</p>

**Images and data compiled from following sources; www.transmaterials.com and www.materialconnexions.com.*

CURRENT MATERIALS USED BY WOOD MANUFACTURERS

Manufacturers of wood products such as furniture, cabinetry, millwork and outdoor products in British Columbia are largely using fairly standard materials such as solid wood, and wood veneers over substrates such as MDF and particle board. In addition they are combining non-wood materials such as glass, metals, fabric/fibre, plastics and a variety of composites with wood to create products with attributes that respond to market demands.

The following information was collected from an FPInnovations survey done at the January 2011 Interior Design Show in Toronto. The information collected represents a ‘snap-shot’ of what is happening currently in terms of materials used in conjunction with wood in Canada.

- **Mixed materials**
 - 14 products were identified that used ‘mixed materials’. Of these products, 8 used some kind of metal, two involved concrete, 4 had some element of glass, 2 had some form of plastics, 1 had recycled rubber and 1 leather.
 - 10 of these products were modern or contemporary in styling, 3 were traditional or rustic and style was not applicable to one product.
 - The most common connections between materials were mechanical but there was also one friction fit component and one sewn joint.
 - All 14 of the products exhibiting mixed materials were mid-high end.

- The products were from a variety of countries including: Canada(6), Italy(3), USA(1), Poland(1), Slovenia(1), and China(1)
- The product categories represented included; furniture(5), kitchen cabinets(3), closet organizers(2), garage cabinets(1), finish(1), stair parts(1), countertops(1).
- **Specific product reviews from the 2011 Interior Design Show:**
 - ‘Make It Metal’ is a metallic finish for wood. This product can be sprayed on and polished and comes in; brass, bronze, pewter, aluminum and copper.
 - Ef.Etch Design uses recycled rubber attached to wood to make seating.
 - Jean Willoughby makes cast concrete cabinets with wood doors.
 - Amy Keeler mixes sheet metal and wood in furniture.
 - Holtz makes a table using glass legs and a wood top.
 - Several Italian cabinet companies were showing entire lines that had little or no wood.
 - One Italian company had a countertop product that appeared to be layered plastic laminate.
 - A closet organizer company used leather over particleboard as a surface.

Material Trends in the North American Market

The following list of trends was gleaned from an online search.

- Mixing materials is very prominent in the kitchen cabinet market
 - rustic textures (such as reclaimed, character marked, or rough sawn wood) are often combined with smooth materials
- Special textures are added to wood surfaces
 - artistic carvings, wood tattoos, printed & laser marquetry, and metallic fillers
- Polymer cabinets are prevalent in outdoor kitchen cabinetry.
- New laminate technologies include:
 - extremely high-gloss and very matte finishes
 - greenguard and FSC certified plastic laminates
 - laminates that can be special ordered with any digital image
 - natural looking patterns such as wood (rustic or distressed or clear grained), granite and marble, leather, etc. due to ever improving technologies and print fidelity which give an extremely high degree of clarity
 - textural patterns such as woven, pinstripes etc.
 - bold images, especially those with architectural elements or organic elements
 - solids in neutrals such as complex shades of browns, beiges, greens and grays that are chameleon like in that they are designed to look different depending on the environment
 - pearlescence which have a subtle iridescent shimmer
 - high-performance surfaces that provide increased scuff, mar and wear resistance.
 - 3D laminate that is available in more natural looking patterns such as driftwood.

- New solid surface materials are also available. Resin based translucent panels can encapsulate textiles, organic materials, and custom images. This type of material is being used for walls, doors and lighting elements.
- When it comes to kitchen and bath innovation the world looks to Italy and Germany for design and manufacturing trends. Although still a small section of the overall market, interest in European influenced cabinetry is growing among North American consumers, who are looking for a more clearly defined choice.
- Mixed materials are also growing in popularity for outdoor products
 - wood pergolas with aluminum elements
 - wood fence panels with plexiglass inserts
 - deck tiles made from wood and ceramic

OPPORTUNITIES FOR MANUFACTURERS

The ideas and information presented in this study are intended for use by manufacturers to inform new product development. Using new or different materials in conjunction with wood can benefit manufacturers through differentiated design, improved product performance and higher margins. Simply put it can, if well executed, elevate the level of product sophistication a manufacturer can offer. However, the mixing of materials adds complexity to business processes and needs to be carefully planned to garner benefits. The three main areas manufacturers will need to attend to are; feasibility, design, and marketing.

Feasibility

To decide if a new material will succeed in the marketplace one has to analyze the technical suitability of the material for the application, do an estimate of production cost, and determine the market trade-off between performance attributes and cost.

Establishing the economic viability of a new product early on is key. A product is economically viable if its value in the marketplace is greater than its cost by a sufficient margin to justify the investment required to make it. Techniques of cost modeling allow estimates to be made on the cost of production. Assessing value is more difficult, as it often requires market research to establish the consumer's perception of the product, the importance they attach to performance, and the nature of the competition. Value depends on the market and industry at which the product is targeted. For example, stainless steel cabinetry may have a high value to health care facilities but perhaps less so to the average homeowner.

Market forecasting involves gathering application-specific market preferences, making an estimate of the technically and economically viable market size, and predicting the timing and industrial adoption by comparison of relevant historical precedents. Not all industries are equal in their adoption of new materials or products. The introduction of a new product into the construction industry, for example, requires careful long-term planning. This industry has been notoriously conservative due to the stringent standards and codes involved. However this is starting to change as some building products have greater environmental impact than others and as a result, the building products industry is being forced to adapt to

new ‘greener’ materials quite quickly. Industries such as furniture and cabinetry on the other hand, are highly subject to fashion trends and so new materials/products are adopted much easier.

A manufacturer must also consider its own organizational structure. Can expansion be added and managed? Or can components be outsourced with good results?

When new technologies and materials are created, it takes time to ‘practice’ with their application before they become fully known, understood and adopted. The smaller the scale of the business, the more readily that can happen. Products such as furniture can be more experimental than say its structural building products. In addition, when the application and usefulness of the product is more mainstream, the adoption is much easier. In contrast, the more exotic and experimental an object is, the more difficult its adoption will likely be. Often, the experimentation happens in smaller scale, creative industries before it is adopted elsewhere. A good example of this is Corian™. When Dupont first introduced this material it was very expensive due to its high research and development costs and while its unique properties were widely appreciated, it was not a big seller. Several years later, with increased competition, Corian™ has more acceptable pricing and is also more readily available and as such, is becoming more mainstream. This type of evolution of a material follows a typical research and development pattern.

Design

Any addition of materials, like any new product development activity, needs to add value. It should add value in one or more of the following ways; improved aesthetic appeal, improved performance or a more cost effective product.

Mixing materials can be used to achieve various **aesthetics**. As mentioned earlier, it is most frequently seen today in modern or contemporary styles and to be most successful, the new material must be fully integrated in the overall design, not just an add-on. Does it add a sense of sophistication? Can it add to the products’ sense of comfort? The choice of materials can contribute to these things. Adding a new material creates differentiation/specialization in a world where there are so many products competing for the consumer’s attention.

In addition to adding aesthetic value, a new material should add performance attributes. Using a new material can reduce weight, improve durability or add strength. Are there code implications? Can it improve installation or improve functionality? Does the material itself do something special, for instance by generating energy, processing waste, is self-cleaning, integrated sensors that warn the user or a smart system that responds to the environment?

It is important when combining materials to pay attention to the suitability of joining technologies, as failure at the junction point must be avoided. Connections influence the total product life cycle, assembly time, use, maintenance and the disassembly of the product. Today, many products are made up of multi and hybrid materials to fulfill increasing product requirements. Joining methods can be mechanical, adhesive and thermal. The joint shown to the right is an extruded aluminum dovetail that saves labour because it reduces the need for clamping.



The chair prototype below was constructed using plywood with rubber embedded in it. When cut precisely the revealed rubber layer becomes a flexible joint.



The local designer/artist/craftsperson community can be drawn on for assistance in working with new materials. Often these individuals tend to be leaders in the innovative use of materials because they are willing to experiment and immerse themselves in a material rather than concerning themselves only with commercial outcomes.

Cross-fertilization between industries can also be useful in new material exploration. Materials developed for a specific role in one industry can often be used in other industries to great advantage. Look at what industries are doing in your area for inspiration and sources for materials.

Adding a new material can, in some cases, **reduce costs**. Plastics are often made to resemble other materials but cost much less. In addition, material innovation is equal to exclusivity, uniqueness and sometimes novelty and as a result, there is a percentage of the market willing to pay for these features.

Marketing/Branding

When chosen correctly, materials will make a product more successful as well as add to a company's brand equity. Many companies make material a key component of their brands and their marketing efforts reflect the value a new material brings.

Generally, there are four ways new materials or products are positioned. They can be positioned as **functional** by focusing on the problems they solve and the benefits provided to the customers. They can be positioned as **symbolic** where their use enhances customers' self-image or ego. Although currently, meaningfulness and fulfillment are even more successful approaches. New materials or products can be positioned as **experiential** by providing sensory or cognitive stimulation. Lastly, they can be positioned as **differentiation** where specialization, improved performance or reduced costs are highlighted.

OBSTACLES TO ADDING MATERIALS

The main obstacles to overcome for manufacturers considering the incorporation of new materials include; costs, access to materials/outsourcing, and the learning curve required.

There is no doubt that involving a new material in production will have associated **costs**. Unless the new material or component will be outsourced and not require any in-house processing, there will be tooling costs. In some cases, these extra costs can be subsidized through Government incentive programs for R&D such as through IRAP and the SR&ED tax credits. These programs offer assistance for a variety of R&D related activities such as; designing and developing new or improved products, prototype and sample development, materials research, integrating new materials to improve product performance and

manufacturing processes, determining tooling requirements and optimal placement of equipment.

If the plan is to outsource materials or components, then the availability of these **sources** can be an issue. It is possible to outsource from overseas but this has risks and upfront costs associated.

The **learning** curve associated with involving your business in a new material is significant. There will be education and training for staff, perhaps time and cost to develop required software, and increased maintenance expenses.

There may be difficulties in introducing important changes to the organization. There may be information-related problems such as lack of scientific and technical information, technological services, and technical support from vendors. Relying on supplier specifications can be dangerous since they tend to be overly optimistic. Technical research papers are more objective but often difficult to extract pertinent info from and time consuming to read.

With new materials come risks and uncertainties as the new material could fail to perform, discolour, create a chemical reaction or even disintegrate over time. Introducing a new material today means evaluating its environmental impact and the likelihood of developing an alternative construction process. For example, simplicity in design is becoming important, mainly for environmental reasons. Keeping the number of materials to a minimum, refining the complexity of construction (avoiding glues and complex fasteners etc.) and avoiding unnecessary clutter will lead to more sustainable products. Enabling a product to be taken apart for disposal makes it more likely to be recycled and reused.

CONCLUSIONS

The value-added wood sector constitutes an important part of the Canadian economy. This is true in terms of employment (around 75,000 employees) and revenues (around \$10 billion). Threats such as economic cycles, imports, product and material substitution and, most importantly, changes in consumer preferences call for the continuous adaptation and innovation in this sector.

To retain market significance, Canadian value-added manufacturers must adapt to current opportunities and threats through innovative business, marketing, and design practices. Adding new materials to develop new products is one way to innovate. Material selection is directly related to product performance requirements, cost, and user needs. Within a manufacturing process there are usually many available choices of materials. This document provides an overview of some of the materials that are important to wood product manufacturers. From science students to scientists, there are countless individuals working on the next generation of materials, processes and tools that will allow manufacturers to develop new products. Material innovation can provide an opportunity for Canadian manufacturers to improve their products, increase their profit margin, and become more globally competitive.

RESOURCES

Information about new materials can be found from a variety of sources. The following websites, books, tradeshow and contacts will provide the reader with an edited selection. Each item has a brief annotation to describe the content of the particular resource.

Websites

www.materialintelligence.com

- A website that offers specifiers such as architects, designers and product developers information about materials and technology, mostly panel products.

www.materialsinonline.com

- A distribution company located in the US for architectural products such as; veneers, panels and doors. Its main focus is the commercial and contract sectors throughout North America.

www.surfaceandpanels.com

- An online magazine focused on the design, manufacturer and marketing of pane-based furniture and casegoods. Back issues can be viewed online.

www.materialicious.com

- A user-submitted visual curation site featuring architecture, design, craftsmanship, materials and products.

www.mtrl.com

- An online resource dedicated to providing designers with ‘material about materials’. It provides a forum for designers to share first-hand experiences with materials.

www.asminternational.org

- The website of the Advanced Materials & Processes Society. This group serves the materials science and engineering professions by providing authoritative information on materials and processes from structural to nanoscale.

www.transmaterial.net

- A companion to the three Transmaterial books by Blaine Brownell. This site provides a clear, accessible, and edited listing of the latest and most intriguing new materials commercially available.

www.materialsmoonthly.com

- This site promotes a subscription based service that delivers samples of new materials on a monthly basis. The packages include; samples, and product sheets that include specifications, applications and sourcing options. It helps designers and manufacturers build a state of the art materials library. The annual subscription rate is \$200 + \$20 for shipping to Canada.



www.materialconnexion.com

- Material ConneXion is the leading global platform for material solutions and innovations. They have several offices throughout the world and offer consultation to large companies on material solutions and innovations. They also have huge materials libraries in their offices in New York, Milan, Bangkok, Cologne and Daegu. Bi-monthly newsletters that introduce new materials can be downloaded for this site.

www.azom.com

- A site based out of Australia that is literally the A to Z of materials. Content includes; article, blogs, podcasts, videos all dedicated to new materials.

www.mrs.org

- The Materials Research Society website includes access to their newsletter called MRSBulletin which is full of recent developments in materials research.

Books

- 1) **The Material of Invention**, Manzini, E., (1989) – An iconic and inspiring description of the role of material in ‘invention’.
- 2) **Design of Everyday Things**, Norman, D.A. (1998) – A book that provides insight into the design of familiar products.
- 3) **Materials and Design: The Art and Science of Material Selection in Product Design**, Mike Ashby and Kara Johnson, (2010)– A comprehensive book on material selection that goes beyond properties and technical requirements to the ‘art’ of materials.
- 4) **Ultra Materials: How Materials are Changing the World**, George M. Beyerian and Andrew Dent (2007) – This book was put out by the organization Material Connexion. It explains the context and current applications of new materials and lists numerous resources for learning more.
- 5) **Transmaterials 1, 2 and 3: A Catalogue of Materials that Redefine our Physical Environment**, Blaine Brownwell (2006, 2008, 2010) – A series of three, handbook sized references of a huge number and variety of new materials.

Researchers

Businesses today rarely have the time, money or patience to invest in material R&D however, they can look to academic researchers for information.

- **British Columbia**

- Dr. Warren Poole, Head of the Materials Engineering Department, Faculty of Engineering, University of British Columbia, Telephone 604 822 3674.

- **Manitoba**
 - Raghavan Jayaraman, Director, Composite Materials and Structures Research Group, Department of Material Science and Engineering, Faculty of Engineering, University of Manitoba, Telephone 204 474 7430.
- **Ontario**
 - Jun Nogami, Professor & Chair, Department of Material Science and Engineering, Faculty of Applied Science and Engineering, University of Toronto. Telephone 416 946 0684.

Trade Shows

Local tradeshows directed at the Architecture and Interior Design industries are a good source for new materials.

- **Interior Design Show West (IDSWest)** – Residential design show directed at designers, architects and consumers.
- **Design Northwest/Buildex Vancouver** – An annual show dedicated to the Design, Construction and Real Estate Management industries.

Internationally one of the best shows is **Interzum** which features decorative surfaces, decor papers, wood materials, laminates, edging, surface treatments, adhesives and other materials. There is a hall dedicated to lighting and innovative materials, a hall for semi-finished components for cabinet, kitchen and office furniture. And finally, one dedicated to hardware, locks and furniture components and upholstery materials and accessories will be included in two other halls. There is a version of this show in Germany, China and Russia.

REFERENCES

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- 2) Brownwell, Blake. Transmaterial: A Catalogue of Materials that Redefine our Physical Environment. P.9.
- 3) Brownwell, Blake. Transmaterial 2: A Catalogue of Materials that Redefine our Physical Environment. P.6.
- 4) Beyerian, George M. and Dent, Andrew. Ultra Materials: How Materials Innovation is Changing the World. P. 36.