

# **Eco-Friendly Alternatives to Wood-based Particleboard**

Alyssa Anderson, Anning Yung, Toshikazu Tanaka  
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Advisor: Dr. Paul Jackson  
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## **Introduction**

Environmentally friendly or 'green' building materials are becoming more widely used as our society becomes aware of harmful consequences associated with the use of standard practices in industrial production. These materials are nontoxic and are made from renewable or recyclable resources. They produce little, if any, off gassing and are generally recyclable. Although our knowledge of building green is still relatively new, and in some cases products may be more expensive than building with traditional materials, in the end, the savings and added efficiency are well worth the initial cost. Eliminating the need for non-renewable fossil fuels, such as coal and oil, reduces the amount of carbon dioxide that enters the atmosphere, which otherwise would contribute to the growing problem of global warming (Spiegel and Meadows 1999). By using 'green' building materials, we take upon the responsibility of using earth's resources in a sustainable manner, thus improving resource management, indoor air quality (IAQ), and overall performance and efficiency.

One of the common materials used in building construction is particleboard, which serves numerous functions. Particleboard is commonly used for cabinetry, tabletops, shelving, wall and floor panels, doors, furniture, and other non-structural architectural applications. Particleboard was initially introduced in the 1940s in Germany and the United States. It has undergone significant growth in production since the 1960s and, due to its low manufacturing cost, is still in the forefront of construction design today (Strategis 2003). With advancements in modern technology and increased knowledge of the earth's escalating environmental problems, more attention has been diverged to rectifying and reducing problems associated with the use of conventional particleboard.

Traditionally, particleboard has been made out of wood-based fibers bound together using a formaldehyde resin. The desired thickness is achieved by using a hot press that forms the board into sheets (Advanced Buildings 2005). Particleboard has a homogenous structure and can be manufactured in different sizes, thickness, densities and grades for numerous uses, making it a desirable material with which to work (Strategis 2003).

One of the major challenges associated with wood-based particleboard is the use of formaldehyde resin. Formaldehyde is a volatile, colorless gas with a strong odor that is commonly used in industrial processes, particularly in manufacturing building materials. Pressed wood products, such as wood-based particleboard and medium density fiberboard, are made using adhesive resins containing urea-formaldehyde. Off-gassing levels are at their highest when the products are new, with emissions tapering off as they age. Exposure to formaldehyde in concentrations greater than 0.1 parts per million (ppm) can cause nasal and throat congestions, burning eyes, or headaches as well as increasing the risk of developing cancer (US EPA 1995). It also escalates the number of “sick building syndrome” cases. Many wood-based building materials or furniture products that utilize formaldehyde resins may off-gas, contributing to a reduced IAQ level. Environmentally friendly alternatives to these wood-based materials include products that use polyurethane resins, which can help reduce or eliminate the formaldehyde that otherwise would be emitted into the air.

In this report we intend to compare three companies that strive to produce and sell composite board products that rely on alternatives to conventional wood-based materials. The mission of these companies is to provide a product that emphasizes resource management, reduces toxicity levels, and offers above average performance and durability. Along with

producing 'green' materials, these businesses put forth the effort to educate the public about the environmental benefits associated with the use of their products.

**Environ Biocomposites, LLC.**

**“Remember: Renewable, Recyclable, and Sustainable – All can make a difference in the environment today and tomorrow”**

**-Environ Biocomposites**

Environ Biocomposites, LLC, based out of Mankato, Minnesota, is accredited for their biocomposite products that utilize rapidly renewable agricultural resources, recyclable paper products, and other sustainable materials that can be renewed or grown in a matter of months instead of centuries, as is needed for wood products. As mentioned in their mission statement, the company “strives to manufacture highly engineered composite panels that utilize waste materials and/or renewable resources in an environmentally sound production process, creating highly sustainable products for our customers.” Their biocomposite technology, which produces a product similar to wood-based panels, can be utilized for production of furniture, cabinets, tables, and a variety of other indoor design products (Environ - Environmental Statement 2005). The company is known for creating the first product, Environ<sup>®</sup> biocomposite, to utilize a bio-based resin system to bind the board together (Environ - Environ Company Background 2005). As mentioned in their environmental statement (2005), unlike traditional wood-based particleboard, which generally use a formaldehyde resin, Environ Biocomposites products do not emit any VOCs into the environment, thus meeting the stringent E1 classification of European indoor air quality standards (Environ 2004). The company prides itself in its reduced use of energy and low emissions levels, especially in comparison to companies that produce wood-

based products. Currently, the 180,000 square foot plant is capable of fabricating an impressive 40 million feet of composite material per year (Environ - Environ Company Background 2005).

Environ<sup>®</sup> biocomposite (Figure 1) was the first product introduced after the founding of the company in 1992. Environ is made of a blend of bio-based resin, cellulose fibers, and color additives, which give the composite a look similar to that of granite, while retaining the “workability of fine and exotic hardwoods” (Environ 2004). Its composition primarily consists of post-consumer newsprint, 30-40% in weight (See MSDS attached to EIQ), and soybean resin, 30-40% in weight (See MSDS attached to EIQ). The use of these cellulose fibers gives the product construction properties similar to wood. The durability of Environ<sup>®</sup> exceeds that of traditional hardwoods, and is found to be up to 1.5 times as hard as oak.

Since their start, the company has expanded their product line from only Environ<sup>®</sup> biocomposite to include to other decorative biocomposite products. Dakota Burl<sup>™</sup> (Figure 1), which was introduced in 1999, resembles traditional burl wood and is composed primarily of sunflower hulls, ~84% in weight (See MSDS attached to EIQ), that normally would be burned as waste or used as animal bedding. A third product, Biofiber<sup>™</sup> Wheat (Figure 1), was introduced in 2000 and is made from wheat straw, ~94% in weight (See MSDS attached to EIQ), giving it the rich golden properties seen in traditional hardwood paneling.



**Environ<sup>®</sup> biocomposite**



**Dakota Burl™**



**Biofiber Wheat™**

**Figure 1. Swatches of Environ Biocomposite products. Environ Biocomposite (Sunset), Dakota Burl, and Biofiber Wheat.**

The company's commitment to reducing energy usage is apparent in a variety of aspects, ranging from how the resources are obtained to the delivery of the final products. All of the materials used for production of Environ Biocomposites products are obtained locally. None of the materials are transported farther than the 300-mile radius surrounding the factory's southern Minnesota location, thus reducing energy and emissions associated with transport. The factory's Midwest location also helps to reduce costs associated with shipping to consumers. Until purchased, all products are warehoused locally at the site of production (McCarthy, personal interview). According to Account Executive Krista McCarthy, the equipment used during production processes has been engineered to be very efficient, utilizing significantly less gas in comparison to production of similar wood-based products.

Instead of simply disposing of manufacturing scraps, Environ reuses the majority of pre-consumer waste products for further production of their current products or those under development. The company also works with customers by accepting any damaged products, attempting to reclaim the material and put it back into the product line (McCarthy, personal interview).

As mentioned earlier, unlike wood-based particleboard products, the composites produced by Environ Biocomposites do not use a formaldehyde-based resin. Instead, they use a urethane resin called Polymeric Diphenylmethane Diisocyanate (MDI), which has an extremely low vapor pressure, thus, MDI is considered to be non-volatile. However, if not used properly or if individuals are exposed to MDI, particularly during the production process, symptoms such as asthma-like reactions, eczema, rashes, blisters, or other skin irritations may occur (American Polywater Corp. 2004).

Prices for Environ products range from \$1.98 and \$2.19 per square foot respectively for Biofiber Wheat™ and Dakota Burl™, to \$4.51 per square foot for ¾” boards of the more decorative Environ® biocomposite, thus while somewhat more expensive, they are still able to effectively compete with traditional wood-based paneling products. The long lifespan of up to 150 years also provides another push to “go green” (McCarthy, personal communication).

One of the main limitations to these composite products is that they are designed specifically for indoor, non-structural use. They are also not waterproof, but when finished properly with catalyzed polyurethanes or polyesters, or other standard finishing methods, the board will be water resistant. Applying a finish will also enhance the natural color and performance of the product (Environ 2004).

Since their start, Environ Biocomposites has gained national recognition and their products have been utilized in a number of building projects throughout the country. The Government Center in Mankato showcases Environ® Biocomposite in a vertical panel application (Figure 2), while the Lebanon Hills Visitors Center and Trailhead in Eagan, MN used Biofiber™ Wheat for vertical paneling and used a combination of Dakota Burl™ and Biofiber™ Wheat for casework (Figure 2). The Farmhouse in Boulder CO, an innovative, eco-friendly, and

energy efficient house featuring numerous environmental architecture practices (See <http://thefarmhouse.org/index.htm>), utilized Environ products in their design. These examples, among others, help to present the benefits, both environmentally and aesthetically, associated with using Environ Biocomposites to build in a sustainable fashion.



**Figure 2: Building Applications of Environmental Biocomposites products. Mankato Government Center (left) and Lebanon Hills Visitors Center (right).**

### **Dow Chemical Company**

**“As a vital measure of integrity, we will ensure the health and safety of our communities, and protect the environment in all we do”**

**-Dow Chemical Company**

Dow Chemical Company, based out of Elie, Manitoba, Canada along with a number of divisions located in the U.S., is a leader in innovative science and technology research, and strives to produce environmentally friendly chemical, plastic, and agricultural based products and services to their customers (Dow - About Dow 2005). The company is recognized by their innovated WOODSTALK™ brand BioProducts that use wheat straw, a sustainable resource that can be recycled and renewed annually, in place of wood-based materials. Also, instead of the

conventional formaldehyde binders that are found in numerous kinds of fiberboard products, these products are manufactured using a polyurethane resin binder (Dow - About Us 2005). This resin gives the material exceptional strength and high performance. Also, the amount of volatile organic compounds (VOCs) emitted into the atmosphere is considerably less than the amount established by regulatory agencies (Dow - News & Events 2005). WOODSTALK™ brand products are made smooth, strong, lightweight, and moisture resistance, as well as being produced with excellent craftsmanship (Dow - About Us 2005). WOODSTALK™ is designed to meet and/or exceed nearly all the standards put forth by rigorous industries around the nation (Dow - Product Information 2005). The product is eco-friendly and is a high performance alternative to wood-based particleboard, medium density fiberboard (MDF), plywood and solid wood, as well as other competitive wheat straw products (Dow - About Us 2005).

One such WOODSTALK™ product is their versatile, consistent, durable and economical ‘Gold MR Fiberboard,’ utilized for cabinetry, furniture, case goods, store fixtures, countertops, shelving, and other non-structural design applications (Dow - Product Information 2005). There are many benefits to using this product in comparison to conventional wood-based particleboard. For example, this material is considered to be more ‘green.’ Instead of using trees, it is made out of pMDI and 93% renewable wheat straw fiber (Dow - Product Information 2005). Another benefit to using agricultural products for production is that it reduces the burning of straw after wheat harvest, which otherwise would lead to increased levels of carbon dioxide in the atmosphere (Dow - Product Information 2005). This also allows farmers to turn what would otherwise simply be agricultural waste into revenue as well as increasing the job market. As mentioned above, lower levels of VOCs are emitted, including a 97% emission reduction in formaldehyde (Dow - Product Information 2005). Thus, overt toxic effects and/or sensory

irritations are not a worrisome factor. This product contributes to Leadership in Energy and Environmental Design (LEED) credits by being rapidly renewable, innovative in design, producing low emissions of harmful particles, and being able to reuse resources. This alternative was also ranked as one of the top ten green building products from Building Green Inc. (Dow - Features & Benefits 2005).



**Figure 3: WOODSTALK™ Gold MR Fiberboard. A sample of wheat straw fiberboard.**

Besides being environmental friendly, this alternative to wood-based particleboard is very cost-effective. Compared to other products, it's 10-20% lighter. Tool wear and replacement is also reduced (Dow - Features & Benefits 2005). The consistency of the board improves the cutting, laminating, and routing operations, which can lead to a higher quality product as well as providing both energy and monetary savings. The product is also easy to use and customize (Dow - Features & Benefits 2005). For example, it is very simple to laminate and to coat with a variety of materials and there are less rejected products because of its consistent machinability. In addition, the material is designed to have high quality and durability, such as higher hanging strength and a smooth and uniform surface (Dow - FAQs 2005).

Waste material produced during fabrication is processed in two primary methods. The first technique consists of regrinding the material and putting it back into the production line for new fiberboard. Another method is to simply dispose of and burn the material in a similar

fashion as other wood-based products (Metro Hardwoods personal communications). One advantage this has over traditional particleboards, however, is that harmful emissions are reduced during the burning processes. The overall process of manufacturing the product is less wasteful in that over 90% of waste products are recyclable and reusable (Dow - About Us 2005).

According to Metro Hardwoods, located in Minneapolis, MN, prices for WOODSTALK™ MR Fiberboard are determined by its thickness, however the most common price is \$1.16 per square foot for a ¾” board, where as wood-based particleboard runs at \$0.88 per square foot for ¾” board. Although there is currently no information about exact product lifespan on file, it is estimated that the product should last 3-5 years for retail applications, and substantially longer for home use (Metro Hardwoods, personal communication).

Similar to Environ Biocomposite™, this non-conventional wheat-based fiberboard has its limitations. Materials used are not 100% moisture proof, therefore external use is not recommended (Dow - FAQs 2005). Also, it should not be stored in any locations that are repeatedly exposed to humidity levels of 70% RH. Physical harm during use includes damaging of lungs from inhaling too much accumulated dust and from the off-gassing of diphenylmethane diisocyanate (MDI), an undetectable gas produced from the reaction of pMDI with the moisture from straw (Dow - Health & Safety 2005).

In addition to wheat-based fiberboard, the company has also expanded to include WOODSTALK™ Lauan Plywood Replacement and Finished Shelving, which is applicable in laundry rooms, flooring, closets and pantries (Dow - FAQs-WOODSTALK™ Finished and FAQs-WOODSTALK™ Lauan 2005). Like their ‘Gold MR Fiberboard,’ these two products use renewable wheat straw fiber and a polyurethane resin in place of a formaldehyde binder, to help

contribute to the eco-friendly environment that they strive to achieve (Dow - FAQs- WOODSTALK™ Finished 2005).

Dow Chemical Company has gained national recognition in their ‘green’ building materials and their products have been utilized in numerous building projects. Neil Kelly Cabinetry produces eco-friendly kitchen and bath cabinets composed of a combination of composite fiberboard, Forest Stewardship Council (FSC) certified wood species, and low VOC finishes, see Figure 4 (Dow - News & Events 2005). Case System Incorporated met the challenge to build a green laboratory where they replaced plastic laminated furniture for laboratories with WOODSTALK™ machinable fiberboard.



**Figure 4: Applications of WOODSTALK™. Neil Kelly Cabinetry made with composite fiberboard (left) and a school science laboratory made with WOODSTALK™ fiberboard panels (right).**

Dow Chemical Company strives to reach numerous goals. First and foremost, this includes their ‘vision of zero,’ which means the prevention of injury, illness, accidents, and/or environmental harm as well as providing chemicals that are safe to use, transport, manufacture, and dispose (Dow - Environmental Stewardship 2005). Another primary goal is to operate their facilities in a sustainable manner that helps free environmental problems. In their attempt to provide an eco-friendly ‘green’ community, this company has been honored with numerous

awards and recognition such as the Responsible Care Sustained Excellence Award, OSHA Star of Excellence (safest work place), and the Cleaning Production Award (Dow - Our Commitments 2005).

### **PrimeBoard, Inc.**

**“If safety is one watchword for PrimeBoard, consistency is another”**

#### **-PrimeBoard**

PrimeBoard, Inc., a privately owned company in Wahpeton, North Dakota, is the world's leading manufacturer of agricultural fiber particleboard. It began its operation in June of 1995 and there are currently seventy employees. PrimeBoard, Inc. owns the first plant in the world designed to produce the highest-grade particleboard from wheat straw. The company recognizes that currently the majority of particleboard is composed of wood and a urea formaldehyde resin, which is detrimental to the environment in that it produces harmful emissions as well as reduces wood supplies. Research has been conducted since 1904 with the goal of finding alternatives to particleboard and finally the conclusion that has been drawn is that strawboard is a better alternative (PrimeBoard 2005).

PrimeBoard was founded by Edward Shormam. Shormam and his company have received more than twenty awards, such as Outstanding Young Legislator in 1977; North Dakota, Minnesota, South Dakota Entrepreneur of the year along with a variety of other recognitions. Also, PrimeBoard, Inc. has received a variety of support, both financially and publicly, from private and public organizations that are concerned with environment health, including the U.S. Small Business Association (SBA), and the U.S. Department of Agriculture (USDA) (PrimeBoard Inc. 2005).

PrimeBoard Inc. produces a high quality, industrial grade particleboard that is produced primarily from agricultural fiber residue and an emission-free binder (PrimeBoard Inc. 2005). PrimeBoard can be used for any application that traditional wood-based particleboard could be used for, such as: kitchens, tables, walls, as well as many other products. To produce PrimeBoard, manufacturers currently use 50,000 tons of agricultural fiber annually. As an additional service, PrimeBoard, Inc. offers a Cut-to-Size program. This allows customers to use PrimeBoard for a variety of applications (PrimeBoard Inc. 2005 ).



**Figure 5: PrimeBoard Manufacturing Plant.**

According to PrimeBoard, Inc. (2005), every year the U.S. produces 60 million tons of wheat. However, this wheat is simply trash for farmers and is typically burned off. If only 25% of the wheat straw was used to make PrimeBoard, as many as 150 PrimeBoard plants would be needed to meet the annual U.S. demand for particleboard (PrimeBoard Inc. 2005).

PrimeBoard has created Emission Free Board (EFB) so customers and markets know that the products they are getting produce no harmful emissions. These emissions are usually generated from traditional wood-based particleboard containing urea formaldehyde. As with the previous two companies, PrimeBoard products are produced using the adhesive MDI, which becomes inert and produces no off-gassing (PrimeBoard Inc. 2005). An independent laboratory experiment indicated that, “physical properties of particleboard made from agricultural residue

fiber exceed all industry standards” (PrimeBoard Inc. 2005). Also, it is lighter, more resistant to water, and has laminating properties that are far superior to traditional particleboard. In addition to these features, PrimeBoard is made of annually renewable emission-free resources and adhesive (PrimeBoard Inc. 2005).

PrimeBoard agriculturally based fiber products are formed using 100% annually renewable materials (PrimeBoard Consumer Brochure 2004). Since there are no natural resources consumed in the process, customers are also contributing to a cleaner, safer, and healthier environment. Also, the company boasts that their heating and production system utilizes pre-consumer by-products created during the manufacturing process, making the plant self-sustaining and environmentally friendly (PrimeBoard Consumer Brochure 2004).

PrimeBoard, Inc. has very strict policies to keep the consistency of its product. Through the process of production from the beginning to the end, the quality of the board is the same because of the policies. Also by controlling the amount of raw materials to mix, they can consistently deliver the exact product that we need for a particular application (PrimeBoard Consumer Brochure 2004). PrimeBoard Inc. has three specific ways of dealing with waste products produced during manufacturing. The most common use of waste is to make and sell pellets out of the material, however other disposal methods include burning the material to provide heat or recycling the material back into the manufacturing process (PrimeBoard Inc. personal communication).

The price for PrimeBoard averages around \$0.29 per square foot (width unknown), however prices are known to fluctuate (PrimeBoard, personal communication). Price comparison done by Naval Facilities Engineering Service Center (1999) indicates, that PrimeBoard may cost up to ten cents more per square foot than traditional particleboard. But this could be considered

cost-effective because it makes a better environment, which may lead to improved work efficiency.

PrimeBoard is becoming more widely used in the industrial realm. Some examples of its use include Koch & Co, based out of Seneca, KS. Annually this company uses around 320,000 square feet of PrimeBoard to produce interior doors. Another corporation that utilizes PrimeBoard is WoodCraft Industries of St. Cloud, MN. WoodCraft uses PrimeBoard for kitchen cabinetry and architectural millwork, claiming, “its machining characteristics are better than traditional particleboard” (PrimeBoard Consumer Brochure, 2004).



**Figure 6: Industrial Uses of PrimeBoard. Interior doors produced by Koch & Co. (left) and kitchen cabinetry and architectural millwork by WoodCraft (right).**

### **Conclusion**

As seen above, there are many advantages to using sustainable alternatives to wood-based particleboard. The products produced by Environ Biocomposites, Dow Chemical Company, and PrimeBoard all exhibit many desirable characteristics associated with “green” building materials. There are many similarities between composition, applications, durability, and levels of “greenness” between the products produced by these companies. As an alternative to using formaldehyde resin, all three of the companies strive to reach a “zero emissions” goal by

utilizing MDI, which eliminates the harmful IAQ effects associated with off gassing of VOCs. These similarities make it difficult to distinguish the companies as far as quality is concerned.

One advantage Environ Biocomposites has over Dow and PrimeBoard is that they have a broader product line. The company appears to manufacture more decorative paneling alternatives that are comparable or superior in appearance to conventional materials. For example, their line of Environ biocomposite has an appearance similar to that of granite and is available in a wide array of colors, which makes the material quite appealing when it comes to interior design. Unlike the products produced by Dow and PrimeBoard, Environ Biocomposites draws on a variety of renewable and recyclable materials to produce their products, instead of simply using wheat straw. These sustainable materials include post-consumer newspaper, sunflower hulls, soybeans, as well as wheat straw.

WOODSTALK™ Gold MR Fiberboard and PrimeBoard are perhaps less decorative options, however, price wise their products are significantly cheaper than those produced by Environ Biocomposites. PrimeBoard may be the most favorable option if construction applications only call for a standard particleboard product, as this appears to be the cheapest of the three companies. WOODSTALK™, while slightly more expensive than PrimeBoard, does have the advantage of having a moisture resistant coating.

To conclude, while on average these products may be slightly more expensive than wood products, the benefits seem to be well worth the additional cost. These three companies have the advantage of providing efficient products while creating a relatively pollution free environment. They also strive to impart public awareness to the advantages to building 'green.' These alternatives to wood-based particleboard are still relatively new in the scheme of things. If other companies take the initiative to follow their lead, we will be on our way to a healthy and

sustainable lifestyle. The combination of our country's leadership in industrial technology, along with the help from companies such as Environ Biocomposites, Dow Chemical Company, and PrimeBoard, as well as the consumer's participation in the purchase of these products, will give us the ability to help create a healthier environment, both indoors and out. These companies have created an excellent starting point for further research associated with creating materials that will promote a "greener" planet.

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